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ABSTRACT

This competency-based curriculum guide on the specialty area of sheet metal is part of the Introduction to Construction series. The series is designed with the flexible training requirements of open shop contractors, preapprenticeship programs, multicraft high school programs, technology education programs, and cooperative education programs in mind. This guide contains four instructional units: sheet metal materials, sheet metal tools, sheet metal layout, and sheet metal basic skills. Eight basic components form a unit of instruction: performance objectives (unit and specific objectives), suggested activities for the teacher (an outline of unit contents and an instructor's guide), information sheets, assignment sheets, job sheets, transparency masters and supplements, tests, and answers to tests and assignment sheets. (YLB)

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The Associated General Contractors of America

Introduction to Sheet Metal

instructor edition

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Introduction to Construction Series

89-005904

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INTRODUCTION TO SHEET METAL
COMPETENCY PROFILE

Student: ______________________________ Soc. Sec. No. ______________
Last First MI

PROGRAM ______________ Grade 9 10 11 12 Adult SCHOOL ______________

INSTRUCTOR ______________ SCHOOL ADDRESS ______________ PHONE ______________

STUDENT'S HOME ADDRESS ______________ DATE OF BIRTH ______________ PHONE ______________

STUDENT'S EMPLOYER ______________ ADDRESS ______________ PHONE ______________

CONTACT IN CASE OF EMERGENCY: ______________ PHONE ______________

ADDRESS: ______________

OR ______________

ADDRESS ______________ PHONE ______________

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ON-JOB TRAINING/WORK EXPERIENCE

DURATION OF EMPLOYMENT	JOB TITLE	EMPLOYER	SUPERVISOR'S NAME	ADDRESS OF EMPLOYER	PHONE

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SPECIFIC JOB COMPETENCIES

Directions: Evaluate the trainee using the rating scale below and check the appropriate number to indicate the degree of competency achieved. The numerical ratings of 4, 3, 2, 1, and 0 are not intended to represent the traditional school grading system of A, B, C, D, and F. The descriptions associated with each of the numbers focus on level of student performance for each of the tasks listed below. The written test score line is provided for optional teacher use. It may not be applicable in all cases. "NA" is an appropriate entry in such instances.

Rating Scale:
4 — Skilled — can perform independently with no additional training.
3 — Moderately Skilled — has performed independently during training program; limited additional training may be required.
2 — Limited Practice — has practiced during training program; additional training is required to develop skill.
1 — Exposure Only — general information provided with no practice time; close supervision needed and additional training required.
0 — No Exposure — no information nor practice provided during training program; complete training required.

4 3 2 1 0

☐☐☐☐☐ *Sheet Metal Materials*

☐☐☐☐☐ 1. Identify metals by sight and feel.
☐☐☐☐☐ 2. Lift and move a large sheet of metal according to safety standards.
☐☐☐☐☐ 3. ______________________________

WRITTEN TEST SCORE ______________

4 3 2 1 0

☐☐☐☐☐ *Sheet Metal Tools*

☐☐☐☐☐ 1. Use a circumference rule to perform measuring activities.
☐☐☐☐☐ 2. Identify sheet metal hand tools.
☐☐☐☐☐ 3. ______________________________

WRITTEN TEST SCORE ______________

4 3 2 1 0

☐☐☐☐☐ *Sheet Metal Layout*

☐☐☐☐☐ 1. Practice drawing basic geometric constructions.
☐☐☐☐☐ 2. Lay out to specifications a metal box.
☐☐☐☐☐ 3. Lay out a rectangular duct.
☐☐☐☐☐ 4. Lay out a circle on sheet metal.
☐☐☐☐☐ 5. ______________________________

WRITTEN TEST SCORE ______________

4 3 2 1 0

☐☐☐☐☐ *Sheet Metal Basic Skills*

☐☐☐☐☐ 1. Lay out, then cut with straight snips a 4" × 3" metal rectangle.
☐☐☐☐☐ 2. Lay out, then cut with left-cutting snips a 3-inch metal circle.
☐☐☐☐☐ 3. Lay out, then cut with right-cutting snips a 3-inch metal circle.
☐☐☐☐☐ 4. Lay out and form to specifications a metal box.
☐☐☐☐☐ 5. Lay out and form to specifications a rectangular duct.
☐☐☐☐☐ 6. Lay out and cut sheet metal for a cylinder, then join cylinder to a flat surface with a dovetail notch.
☐☐☐☐☐ 7. ______________________________

WRITTEN TEST SCORE ______________

Use of This Document

This document can be used to record information about the student and the skills mastered by the student. This information is useful in documenting student progress during the training program and to provide information about the student's qualifications to potential employers and for entry into advanced training programs. Instructors using AGC-CIMC instructional materials are authorized to reproduce this document as required for use in their training programs.

Introduction to Sheet Metal

Developed as a Cooperative Project by
The Associated General Contractors of America
William K. Healy, Chairman, Manpower and Training Committee
and
Oklahoma State Board of Vocational and Technical Education
John Folks, Chairman
Roy Peters, Jr., Director

TI1243

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INTRODUCTION TO SHEET METAL

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FOREWORD

In 1985, The Associated General Contractors of America (AGC) met with representatives of the Oklahoma Curriculum and Instructional Materials Center (CIMC) to discuss the possibilities of developing, as a cooperative project, a course of instruction designed for training individuals who choose to seriously explore careers in construction.

This publication is the result of those original discussions and close coordination among general contractors and vocational educators. This series represents a conscious effort to coordinate the practical experience of personnel in the construction industry with the best instructional methods of those in the field of vocational education.

Although this series reflects a systematic approach to instructional materials development and the latest in educational technology innovations, the information in *Introduction to Sheet Metal* should be adapted and modified to coincide with local conditions.

Roy Peters, Jr., Director
Oklahoma State Department of
Vocational and Technical Education

William K. Healy, Chairman
Manpower and Training Committee
The Associated General Contractors
of America

PREFACE

For many years The Associated General Contractors of America (AGC) has recognized the need for providing quality compentency-based instructional materials for the construction industry. AGC and the Oklahoma State Department of Vocational and Technical Education have met this challenge by providing nationally recognized curriculum and services since 1972. In 1986 AGC and Oklahoma's Curriculum and Instructional Materials Center (CIMC) determined a significant need for a series that would address training needs of open shop contractors, preapprenticeship programs, multi-craft high school programs, technology educational programs, CVET, and cooperative education programs. The Introduction to Construction Series was designed with the flexible training requirements of these groups in mind.

The Introduction to Construction Series begins with *Fundamentals of Construction* and progresses to twelve spin-off specialty publications. *Fundamentals of Construction* covers basic knowledge necessary for all individuals in construction. Each specialty area covers basic skills necessary for entry-level employment. Both vocational education and the construction industry offer more advanced courses in each specialty area and should be considered by individuals wishing to establish careers in the industry. Competency profiles (provided in the teacher edition) for the Introduction to Construction Series articulate with several more advanced AGC publications as well as publications developed by the Mid-America Vocational Curriculum Consortium (MAVCC).

Publications in this series include:

- Introduction to Bricklaying
- Introduction to Carpentry
- Introduction to Concrete Masonry
- Introduction to Ironwork
- Introduction to Electricity
- Introduction to Plumbing
- Introduction to Heating, Ventilation, and Air Conditioning
- Introduction to Sheet Metal
- Introduction to Roofing
- Introduction to Drywall
- Introduction to Insulation
- Introduction to Welding

USE OF THIS PUBLICATION

Instructional Units

Introduction to Sheet Metal contains one section and four instructional units. A standard format was established in 1970 for development of instructional materials for all Oklahoma vocational teachers. This format includes eight basic components that form a unit of instruction: performance objectives, suggested activities for the teacher, information sheets, assignment sheets, job sheets, transparency masters and supplements, tests, and answers to tests and assignment sheets. Depending on the specific objectives, there may or may not be transparency masters, supplements, assignment sheets, or job sheets included in the unit of instruction.

All of the unit components "zero in" on measurable and observable learning outcomes. Teachers are encouraged to supplement, personalize, localize, and motivate with these materials in order to develop a complete teaching/learning process.

Units of instruction are designed for use in more than one lesson or class period of instruction. Careful study of each unit of instruction by the teacher will help him or her determine the following

- Amount of material that can be covered in each class period
- Skills that must be demonstrated
  - Supplies and equipment needed
  - Amount of practice needed
  - Amount of class time needed for demonstrations
- Supplementary materials, such as pamphlets and filmstrips, that must be ordered
- Resource people to contact

Performance Objectives (white pages)

Each unit of instruction is based on the performance needed for successful employment in an occupational area. Performance objectives are stated in two forms: unit objectives, stating the subject matter to be covered in a unit of instruction; and specific objectives, stating the performance necessary to reach the unit objective. Since the objectives of the unit provide direction for the teaching/learning process, it is important that teachers and students have a common understanding of the intent of the objectives.

The objective sheet should be given to students and referred to throughout the teaching/learning process. This will help answer any questions concerning performance requirements for each instructional unit. The objectives can also help determine teaching strategies and instructional methods. Prepare for each unit by deciding how each objective can best be taught.

The objective sheet may also be used as a quick pretest to determine students' prior knowledge and to determine whether further study or activities are necessary. Teachers should feel free to modify, delete, or add objectives in order to meet the needs of the students and community. When changes in objectives are made, the teacher should remember to supply the needed information, assignment and/or job sheets, and criterion test items.

Suggested Activities (pink pages)

Suggested activities are included only in teacher materials. The suggested activities pages include an outline of the unit contents and an instructor's guide designed to assist teachers in planning their presentation of the unit. The instructor's guide provides suggestions for delivery and/or presentation during the instructional process. Read the suggested activities before teaching the units so that supplemental materials can be obtained, audiovisual materials prepared, and outside resources contacted. Duties of the teacher will vary according to the particular unit.

The references that are listed in the suggested activities are ones used in the development of each unit. They may be used by the teacher to supplement her or his knowledge of the subject area or to help students with particular interests or occupational objectives in the area covered.

The suggested activities section of the unit also includes supplements and transparency masters. Each of these components provides information in a special way. Supplements may consist of motivational materials, review or practice materials such as crossword puzzles and self-tests, or charts and reference materials. Supplements are designed to be copied and distributed to individual class members or to the class as a whole. Suggestions for their use are included in the instructor's guide. Transparencies direct the class' attention to the topic of discussion. Transparencies may present new information, or they may reinforce information presented in the information sheet. They are particularly effective when identification or analysis is necessary. You may want to make transparencies and place them in the notebook where they will be immediately available for use.

Information Sheet (green pages)

The information sheet provides "must know" content essential for meeting the cognitive (knowledge level) objectives of the unit. The information is written in a topical-outline form and is keyed to the specific objectives.

Teachers will find that the information sheet serves as an excellent guide for presenting background knowledge necessary to develop the skills specified in the unit objective. The information sheet may also be used for coordination activities and advisory committees.

Students should read the information sheet before the information is discussed in class. Space is provided in margins for students and teachers to add notes that supplement, localize, personalize, or provide motivation for each unit.

Assignment Sheets (brown pages)

Assignment sheets give students a chance at problem solving, self-assessment, and/or practical experience. They assist students in the application of knowledges that are necessary prerequisites to skill development. Assignment sheets may be given to the student for completion in class or may be used for homework assignments. Answer sheets are provided when appropriate and can be used by the student and/or teacher for checking student progress. The scores of those assignment sheets listed in the specific objectives should be averaged with the unit test score, as the skills addressed in these assignment sheets are considered necessary in meeting the unit objective.

Job Sheets (blue pages)

Job sheets are another important segment of a unit of instruction. The job sheets provide a list of equipment, tools, and materials needed to complete a manipulative or psychomotor skill. They describe a step-by-step procedure needed to complete each task or job. Diagrams, photographs, and illustrations are provided to assist students in achieving the skill.

The teacher should demonstrate to students the procedures outlined in each job sheet. Furthermore, the teacher needs to localize the job sheet according to the equipment and supplies available in the local lab or shop situation. Job sheets also furnish potential employers with a picture of the skills being taught and the performances they might reasonably expect from a person who has had this vocational instruction.

Job sheet performance should be evaluated by the instructor and averaged with the unit test score, as the skills addressed in the job sheets are considered necessary in meeting the unit objective.

Tests (white pages)

Tests are included only in teacher materials. The test provides criterion-referenced evaluation of every objective listed in the unit of instruction. It is crucial to note that both paper/pencil and performance objectives must be evaluated.

It is recommended that the tests be divided into shorter tests covering three or four objectives at a time and given soon after those objectives have been covered. A selection of questions from the units covered may be used for final tests at the end of each term if desired. If objectives have been added, deleted, or modified, be sure to make the changes on the test.

The acceptable response on a unit test, 80 percent in most units, may be raised or lowered to fit the topic or students' ability levels. The percentage applies to the overall score, not to each question. The final unit grade should be obtained by using the paper/pencil score and evaluations of student demonstrations of the desired skills.

Answers to Test and Assignment Sheets (pink pages)

Answers to test and assignment sheets are components designed to assist the teacher in evaluation of student performances.

Page Numbering

Each publication from the Curriculum and Instructional Materials Center (CIMC) is assigned a specific abbreviation. For example, *Introduction to Sheet Metal* has been abbreviated ITSM. The units are then numbered consecutively within each section. An example of a page number is ITSM-1. Since most CIMC publications are loose leaf, this system of page numbering was adopted so that pages from different manuals would not get mixed up.

Methods of Disseminating Material

For best results, provide student materials for each student. Student materials contain everything but the test, supplements, answers to assignment sheets, and suggested activities.

Teaching Methods

It is a challenge to keep students motivated. Supplement the objectives by providing the "why," personal experiences, and current information. Prepare for each unit by deciding how each objective can best be taught. Allow students to become involved in preparing and planning.

Competency Profiles

Competency profiles are used to document student performance. The profile contains a list of the specific job competencies that a student should achieve prior to leaving the training program. A competency profile master is provided in the instructor edition of each publication. Duplicate the profile and distribute to students as required.

Other AGC Publications: AGC updates curriculum products on a continuing basis. For a free catalog describing other AGC products, call the AGC national office at 1-202-393-2040.

CORRECTIONS AND SUGGESTIONS

The Curriculum and Instructional Materials Center (CIMC) wants to provide vocational instructors and students with materials that are accurate and effective. Although the CIMC strives to maintain the highest standards of development and production, oversights occasionally do occur. If you find any errors in this or other CIMC publications, or have suggestions for improving their usefulness in vocational programs, please notify the CIMC staff. One easy way of pointing out errors is to make a photocopy of the affected page and to indicate the correction on the copy. You can mail the information to the CIMC, where it will be used to correct the publication before the materials are reprinted.

To ensure that the material is updated on a timely basis, it is important that you notify the CIMC of necessary corrections as soon as possible after discovering the error. Do not assume that someone else will notice the error and inform the CIMC; other users may be making the same assumption. Please send corrections and recommendations for improving this publication to the following address:

Coordinator for Curriculum Development
Curriculum and Instructional Materials Center
Oklahoma State Department of Vocational and
Technical Education
1500 West Seventh Avenue
Stillwater, Oklahoma 74074-4364

SHEET METAL MATERIALS
UNIT I

UNIT OBJECTIVE

After completing this unit, the student should be able to identify different types of metal used in sheet metal work. The student will show this knowledge by completing the assignment and job sheets and unit test with a minimum score of 80 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match terms associated with sheet metal materials to their definitions.
2. Match metals with ways to identify them by sight and feel.
3. Complete a chart showing metals most commonly used in sheet metal work.
4. Complete a chart showing other metals used in sheet metal work.
5. State safety rules for handling large sheets of metal.
6. Identify metals by sight and feel.
7. Demonstrate ability to lift and move a large sheet of metal according to safety standards.

SHEET METAL MATERIALS
UNIT I

SUGGESTED ACTIVITIES

I. Unit contents

  A. Objective sheet

  B. Suggested activities

  C. Transparency masters

    1. TM #1 — Galvanized Carbon Steel Sheets

    2. TM #2 — Carbon Steel and Brass Sheets

    3. TM #3 — Copper and Zinc Sheets

    4. TM #4 — Stainless Steel Sheets

    5. TM #5 — Aluminum Sheets

  D. Information sheet

  E. Assignment Sheet #1 — Identify Metals by Sight and Feel

  F. Answers to assignment sheet

  G. Job Sheet #1 — Lift and Move a Large Sheet of Metal According to Safety Standards

  H. Test

  I. Answers to test

II. Instructor's guide

  A. Review unit and plan presentation.

  B. Obtain materials to supplement unit.

    1. Sample pieces of as many different types of metal as possible.

    2. Materials and tools necessary to accomplish procedures in job sheet.

  C. Make copies of transparencies for each student.

  D. Introduce unit to students.

SUGGESTED ACTIVITIES

E. Provide students with objective sheet.

F. Discuss unit and specific objectives.

G. Provide students with information, assignment, and job sheets.

H. Discuss information, assignment, and job sheets.

1. Use Information Sheet, Section I, to discuss terms and definitions associated with sheet metal materials.

   - Have students review terms.

   - Explain to students the importance of knowing these terms and definitions and how knowing them will help the student to better understand this unit.

2. Use Information Sheet, Section II, to discuss metals and ways to identify them by sight and feel.

   - Display samples of the various types of metals.

   - Have students review Section II of the information sheet.

   - Let students examine the metal samples so they may feel the difference in each type and so they can better learn to identify them.

   - Use the assignment sheet to reinforce discussion on the different types of metals.

   - Have students complete Assignment Sheet #1.

3. Use Information Sheet, Sections III and IV, to discuss the various metals used in sheet metal work.

   - Discuss types of metals, their uses, characteristics and their resistance to rust.

   - Discuss the gauge number, weight, and thickness of the various types of sheet metal.

   - Give students copies of the transparencies.

   - Use the transparencies to reinforce your discussion.

4. Use Information Sheet, Section V, to discuss safety rules for handling large sheets of metal.

   - Explain the importance of these safety rules and any other safety rules.

SUGGESTED ACTIVITIES

- Point out how easily someone could get seriously injured if the safety rules were not observed.
- Demonstrate procedures in the job sheet.
- Have students demonstrate procedures in the job sheet.
- Have students complete Job Sheet #1.

I. Give test.

J. Critique test and discuss in class.

K. Reteach and retest as necessary.

L. Complete appropriate section of competency profiles.

(NOTE: A master of the competency profile for this book is provided at the front of the instructor edition. You may duplicate the profile and distribute it to students as needed.)

III. Unit reference — Jones, Leonard and Morse, Otto. *Sheet Metal Basics*. Stillwater, Oklahoma; Mid-America Vocational Curriculum Consortium, Inc., 1983.

Galvanized Carbon Steel Sheets

Gauge #	Lbs Per Sq Ft (Approximate)	Thickness Equivalent	Thickness Range in Inches
8	7.03125	0.1681	.1756-.1607
9	6.40625	0.1532	.1606-.1458
10	5.78125	0.1832	.1457-.1308
11	5.15625	0.1233	.1307-.1159
12	4.53125	0.1084	.1158-.1009
13	3.90625	0.0934	.1008-.0860
14	3.28125	0.0785	.0859-.0748
15	2.95875	0.0710	.0747-.0673
16	2.65625	0.0635	.0672-.0606
17	2.40625	0.0575	.0605-.0546
18	2.15625	0.0516	.0545-.0486
19	1.90525	0.0456	.0485-.0426
20	1.65625	0.0396	.0425-.0382
21	1.53125	0.0366	.0381-.0352
22	1.40625	0.0336	.0351-.0322
23	1.28125	0.0306	.0321-.0292
24	1.15625	0.0276	.0291-.0262
25	1.03125	0.0247	.0261-.0232
26	0.90625	0.0217	.0231-.0210
27	0.84375	0.0202	.0209-.0195
28	0.78125	0.0187	.0194-.0180
29	0.71875	0.0172	.0179-.0165
30	0.65625	0.0157	.0164-.0150
31	0.59375	0.0142	.0149-.0138
32	0.56250	0.0134	.0137-.0131

Carbon Steel and Brass Sheets

Carbon Steel		
USS Gauge #	Thickness Equivalent	Lbs Per Sq Ft (Approximate)
1	.28125	11.250
2	.26562	10.620
3	.2391	10.000
4	.2242	9.375
5	.2092	8.750
6	.1943	8.125
7	.1793	7.500
8	.1644	6.875
9	.1494	6.250
10	.1345	5.625
11	.1196	5.000
12	.1046	4.375
13	.0897	3.750
14	.0747	3.125
15	.0673	2.812
16	.0598	2.500
17	.0538	2.250
18	.0478	2.000
19	.0418	1.750
20	.0359	1.500
21	.0329	1.375
22	.0299	1.250
23	.0269	1.125
24	.0239	1.000
25	.0209	.875
26	.0179	.750
27	.0164	.687
28	.0149	.625
29	.0135	.526
30	.0120	.500

Brass		
American Gauge #	Thickness Equivalent	Lbs Per Sq Ft (Approximate)
1	.2893	12.75
2	.2576	11.35
3	.2294	10.11
4	.2043	9.002
5	.1819	8.015
6	.1620	7.138
7	.1443	6.358
8	.1285	5.662
9	.1144	5.041
10	.1019	4.490
11	.1907	3.997
12	.0808	3.560
13	.0720	3.173
14	.0641	2.825
15	.0571	2.516
16	.0508	2.238
17	.0453	1.996
18	.0403	1.776
19	.0359	1.582
20	.0320	1.410
21	.0285	1.256
22	.0254	1.119
23	.0226	.9958
24	.0201	.8857
25	.0179	.7887
26	.0159	.7006
27	.0142	.6257
28	.0126	.5552
29	.0113	.4979
30	.0100	.4406

Copper and Zinc Sheets

Copper		
Gauge #	Thickness Equivalent	Lbs Per Sq Ft (Approximate)
1	.300	13.94
2	.284	13.20
3	.259	12.04
4	.238	11.07
5	.220	10.22
6	.203	9.420
7	.180	8.360
8	.165	7.660
9	.148	6.875
10	.134	6.225
11	.120	5.575
12	.109	5.065
13	.095	4.410
14	.083	3.860
15	.072	3.338
16	.065	3.020
17	.058	2.695
18	.049	2.280
19	.042	1.952
20	.035	1.627
21	.032	1.484
22	.028	1.302
23	.025	1.162
24	.022	1.022
25	.020	.928

Zinc		
Gauge #	Thickness Equivalent	Lbs Per Sq Ft (Approximate)
24	.125	4.70
23	.100	3.75
22	.090	3.37
21	.080	3.00
20	.070	2.62
19	.060	2.25
18	.055	2.06
17	.050	1.87
16	.045	1.68
15	.040	1.50
14	.036	1.35
13	.032	1.20
12	.028	1.05
11	.024	.90
10	.020	.75
9	.018	.67
8	.016	.60
7	.014	.52
6	.012	.45
5	.010	.37
4	.008	.30
3	.006	.22
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Stainless Steel Sheets

Thickness Ordering Range in Inches	Gauge #	Thickness Equivalent	Lbs Per Sq Ft (Approximate) Cold Rolled
.161 to .176	8	.17187	7.2187
.146 to .160	9	.15625	6.5625
.131 to .145	10	.140625	5.9062
.115 to .130	11	.125	5.5200
.009 to .114	12	.109375	4.5937
.084 to .098	13	.09375	3.9374
.073 to .083	14	.078125	3.2812
.066 to .072	15	.0713125	2.9521
.059 to .065	16	.0625	2.6250
.053 to .058	17	.05625	2.3625
.047 to .052	18	.050	2.1000
.041 to .046	19	.04375	1.8375
.036 to .040	20	.0375	1.5750
.033 to .035	21	.034375	1.4437
.030 to .032	22	.03125	1.3125
.027 to .029	23	.028125	1.1813
.024 to .026	24	.025	1.0500
.0199 to .023	25	.021875	0.9187
.0178 to .0198	26	.01875	0.7875
.0161 to .0177	27	.0171875	0.7218
.0146 to .0160	28	.015625	0.6562
.0131 to .0145	29	.0140625	0.5906
.0115 to .0130	30	.0125	0.5250
.0105 to .0114	31	.0109375	0.4594
.0095 to .0104	32	.01015625	0.4265

Aluminum Sheets

Thickness and Size, Inches	Mill Finish							
	1100		3003		5052			5086
	-0	-H14	-0	-H14	-0	-H32	-H34	-H32
.190 × 36 × 96				X*		X		
48 × 120				X*				
48 × 144		X		X*	X	X*		
60 × 144				X*				
.160 × 48 × 144						X		
.125 × 36 × 96	X			X		X*		
48 × 96				X*		X*		
48 × 120				X*				
48 × 144		X	X	X*	X	X*	X*	X
60 × 144				X*		X*		
.100 × 48 × 144						X*		
.090 × 36 × 96						X*		
48 × 96						X		
48 × 144					X	X*	X*	
.080 × 48 × 96						X		
48 × 144						X*	X	
.063 × 36 × 96		X						
48 × 96						X*		
48 × 144					X	X*	X	
60 × 144				X				
.050 × 48 × 144						X*		
.040 × 48 × 144						X		
.032 × 48 × 144						X		

X — Standard items

X* — Plant stocks available

O — Indicates sheet has been annealed

H — Indicates sheet has been strain-hardened

(NOTE: The digit 1 following the letter H means sheet has been strain-hardened only, or subjected to stress to improve strength and hardness. Second digit indicates hardness on a scale of 0 to 7, so a 3003-H14 indicates the sheet has been strain-hardened only and is medium hard. The 3003-H14 aluminum sheet is the most commonly used sheet in the industry.)

SHEET METAL MATERIALS
UNIT I

INFORMATION SHEET

I. Terms and definitions associated with sheet metal materials

- A. **Ferrous metals** — Metals having iron or steel content
- B. **Nonferrous metals** — Metals having no iron or steel content
- C. **Hot-rolled** — Steel formed while it is white hot out of a blast furnace; it is rolled to reduce thickness, increase length, and produce sheets or rolls
- D. **Cold-rolled** — Steel formed from hot-rolled steel cooled to room temperature; it is rolled to give it springiness or other tempering characteristics; has more precision forming than hot-rolled steel and costs a little more
- E. **Malleable** — Metal that can be easily shaped or formed
- F. **Sheen** — Brightness or shininess
- G. **Alloy** — Metal made by combining two or more metals
- H. **Annealing** — Process of softening and removing stress from metals by heating, then slowly cooling them
- I. **Extruded** — Metal or plastic that has been forced through a special die to extend, form, and reshape it

II. Metals and ways to identify them by sight and feel

- A. Galvanized iron — Has a high sheen and presents a flaky-patterned surface appearance; usually thin and flexible
- B. Black iron — Bluish gray to dull gray; ranges from flexible to very rigid and is uncoated
- C. Aluminum — Has a silvery, smooth finish with a medium sheen; usually thin, soft, and flexible
- D. Stainless steel — Has a chrome-colored, smooth finish, frequently with a satin-like appearance; usually thin and flexible, yet hard
- E. Paint grip iron — Has a dull gray color; usually thin and flexible
- F. Brass — Has a yellowish color; usually rigid but readily malleable
- G. Copper — Has a reddish-brown color; usually soft and flexible
- H. Zinc — Has a bluish gray color; rigid and brittle

INFORMATION SHEET

III. Metals most commonly used in sheet metal work (Table 1)

TABLE 1

Metal	Characteristics	Rust Resistance	Typical Uses
Galvanized iron	Hot-rolled metal dipped in hot galvanneal	Excellent	Duct work, roof metal, blow pipes, and general sheet metal work
Black iron	Cold-rolled is harder and more expensive; hot-rolled is softer, less expensive and used more; easier to weld than galvanized	None; must be painted when job is finished	Service truck tool boxes, heat exchangers, horse trailers, and generally in applications requiring added strength
Aluminum	Has a protective coating of oxide film; smooth or decorative finishes or a highly polished anodized finish; usually light weight and easy to handle	Excellent	Gravel guard and fascia, finish siding for campers and mobile homes, and airplane fabrication; extruded for roofing and other applications.
Stainless Steel	A steel alloyed with nickel and chromium; durable, and polished to various degrees	The best of all metals	Labs, hospitals, meat packing plants, restaurants, and applications where cleanliness and attractiveness are required
Paint Grip Iron	A cold-rolled iron electroplated with a zinc process and ready to paint	Fair for a time but still requires paint	Sign work, roof metals, and general commercial construction.

INFORMATION SHEET

IV. Other metals used in sheet metal work (Table 2)

TABLE 2

Metal	Characteristics	Rust Resistance	Typical Uses
Brass	Made by melting copper and zinc together; comes in a thin sheet called shim stock	Excellent	Automotive shops, etched decorative plaques, trophies, brass rods for brazing, and many ornamental and decorative applications
Copper	Attractive metal, but tarnishes easily; comes in wire, tube, and sheet; soft and easy to work with	Excellent	Roofing flashings, counter flashings, and many other roofing applications; electrical wiring, refrigeration and plumbing piping, and many decorative applications
Zinc	Usually used as an alloy or a coating for other metals	Excellent, but will tarnish	Additive to cut acids and as coatings for other metals
Expanded Metal	Made from flat steel sheet run through a stamping machine, then stretched to leave it full of diamond-shaped holes	None; must be painted when job is finished	Belt guards, catwalks, and protective guards for the back windows of pickups and trucks
Decorative Metal	Stamped with various punch patterns to create attractive designs; usually made from aluminum plate and available in many lively colors	Excellent	Return air openings, shelf work, and many ornamental and decorative applications

INFORMATION SHEET

V. Safety rules for handling large sheets of metal

A. Know the exact area to which the sheet will be moved

B. Have another student or co-worker help; *never* attempt to move a large sheet of metal by yourself

C. Use locking pliers as handles; adjust both sets of pliers to proper locking pressure before starting to lift or move the sheet

D. Get a firm grip on the metal sheet; *do not* attempt to move until you're sure the sheet will not slip

CAUTION

Because many sheet metals are treated with oil, they must be gripped firmly whether stacked flat or standing in a rack. If the sheet slips away at the very beginning, it poses a safety hazard to the workers moving it and could easily be damaged or damage sheets below or beside it.

E. Move sheet so that locking pliers can be placed at each end of the sheet to provide a center of balance

F. Clamp locking pliers into position on each end of the sheet

G. Lift sheet to a safe distance off the floor, and with both workers on the same side of the sheet, carry it to the work area

H. Place the sheet down slowly or secure it in the work area before releasing the locking pliers

I. After cutting the proper working size, return metal to rack to ensure that fellow workers are not injured by metal protruding over edge of work bench

SHEET METAL MATERIALS
UNIT I

ASSIGNMENT SHEET #1 — IDENTIFY METALS BY SIGHT AND FEEL

NAME ______________________________ SCORE ______________

Sheet metal workers must be able to identify the kinds of metals they are working with. This assignment sheet will give you practice in recognizing various kinds of metal by their appearance and feel.

Your instructor will arrange on a work bench ten different metals with numbers attached to each. Determine by sight and feel what each metal is and complete the following worksheet. Be sure to complete your reasons for naming each metal by indicating whether your conclusion was based on the color of the metal, the texture or feel of the metal, or both.

A. Metal #1 is: __________. Reasons: ______________________________
____

B. Metal #2 is: __________. Reasons: ______________________________
____

C. Metal #3 is: __________. Reasons: ______________________________
____

D. Metal #4 is: __________. Reasons: ______________________________
____

E. Metal #5 is: __________. Reasons: ______________________________
____

F. Metal #6 is: __________. Reasons: ______________________________
____

G. Metal #7 is: __________. Reasons: ______________________________
____

H. Metal #8 is: __________. Reasons: ______________________________
____

I. Metal #9 is: __________. Reasons: ______________________________
____

J. Metal #10 is: __________. Reasons: ______________________________
____

SHEET METAL MATERIALS
UNIT I

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1 — Evaluated to the satisfaction of the instructor.

SHEET METAL MATERIALS
UNIT I

JOB SHEET #1 — LIFT AND MOVE A LARGE SHEET OF METAL ACCORDING TO SAFETY STANDARDS

I. Tools and materials

  A. Sheet metal as selected by instructor

  B. Two pairs of locking pliers

II. Procedure

  A. Select a co-worker or fellow student to assist

  B. Determine the work area to which the sheet of metal is to be moved

  C. Adjust both locking pliers so that they will firmly grip the metal

  D. Work as a team of two and lift or move the sheet of metal to a point that the locking pliers can be applied and secured on each end at a point of balance

  E. Stay on the same side of the sheet metal as your co-worker and use the locking pliers as handles to lift the sheet metal off the floor

  F. Carry the sheet metal to the selected work area

  (NOTE: If you have selected a good center of balance, the sheet metal may lean slightly onto the shoulder of each worker.)

  G. Set the sheet metal down and position it in the work area

  H. Remove the locking pliers

  I. Inspect the sheet metal for any damage

  J. Have your instructor check the sheet metal

  K. Return tools to proper storage area

SHEET METAL MATERIALS
UNIT I

TEST

NAME ________________________________ SCORE ______________

1. Match terms associated with sheet metal materials to their definitions. Write the correct numbers in the blanks.

_____a. Metals having iron or steel content

_____b. Metals having no iron or steel content

_____c. Steel formed while it is white hot out of a blast furnace; it is rolled to reduced thickness, increase length, and produce sheets or rolls

_____d. Steel formed from hot-rolled steel cooled to room temperature; it is rolled to give it springiness or other tempering characteristics; has more precision forming than hot-rolled steel and costs a little more

_____e. Metal that can be easily shaped or formed

_____f. Brightness or shininess

_____g. Metal made by combining two or more metals

_____h. Metal or plastic that has been forced through a special die to extend, form, and reshape it

_____i. Process of softening and removing stress from metals by heating, then slowly cooling them

1. Malleable
2. Nonferrous metals
3. Sheen
4. Ferrous metals
5. Hot-rolled
6. Alloy
7. Cold-rolled
8. Annealing
9. Extruded

2. Match metals with ways to identify them by sight and feel. Write the correct numbers in the blanks.

_____a. Has a high sheen and presents a flaky-patterned surface appearance; usually thin and flexible

_____b. Bluish gray to dull gray; ranges from flexible to very rigid and is uncoated

_____c. Has a silvery, smooth finish with a medium sheen; usually thin, soft, and flexible

1. Galvanized iron
2. Zinc
3. Black iron

TEST

_____d. Has a chrome-colored, smooth finish, frequently with a satin-like appearance; usually thin and flexible yet hard

_____e. Has a dull gray color; usually thin and flexible

_____f. Has a yellowish color; usually rigid but readily malleable

_____g. Has a reddish-brown color; usually soft and flexible

_____h. Has a bluish gray color, rigid and brittle

4. Copper
5. Stainless steel
6. Brass
7. Aluminum
8. Paint grip iron

TEST

3. Complete the following chart showing metals most commonly used in sheet metal work.

Metal	Characteristics	Rust Resistance	Typical Uses
Galvanized iron	a. ____________ ____________ ____________	Excellent	Duct work, roof metal, blow pipes, and general sheet metal work
Black iron	Cold-rolled is harder and more expensive; hot-rolled is softer, less expensive and used more; easier to weld than galvanized	None; must be painted when job is finished	Service truck tool boxes, heat exchangers, horse trailers, and generally in applications requiring added strength
Aluminum	Has a protective coating of oxide film; smooth or decorative finishes or a highly polished anodized finish; usually light weight and easy to handle	Excellent	Gravel guard and fascia, finish siding for campers and mobile homes, and airplane fabrication; extruded for roofing and other applications
b. ____________ ____________	A steel alloyed with nickel and chromium; durable, and polished to various degrees	c. ____________ ____________	Labs, hospitals, meat packing plants, restaurants, and applications where cleanliness and attractiveness are required
Paint Grip Iron	A cold-rolled iron electroplated with a zinc process and ready to paint	Fair for a time but still requires paint	d. ____________ ____________

TEST

4. Complete the following chart showing other metals used in sheet metal work.

Metal	Characteristics	Rust Resistance	Typical Uses
a. ____________	Made by melting copper and zinc together; comes in a thin sheet called shim stock	Excellent	Automotive shops, etched decorative plaques, trophies, brass rods for brazing, and many ornamental and decorative applications
b. ____________	Attractive metal, but tarnishes easily; comes in wire, tube, and sheet; soft and easy to work with	Excellent	Roofing flashings, counter flashings, and many other roofing applications; electrical wiring, refrigeration and plumbing piping, and many decorative applications
c. ____________	Usually used as an alloy or a coating for other metals	Excellent, but will tarnish	Additive to cut acids and as coatings for other metals
d. ____________ ____________	Made from flat steel sheet run through a stamping machine, then stretched to leave it full of diamond-shaped holes	None; must be painted when job is finished	Belt guards, catwalks, and protective guards for the back windows of pickups and trucks
e. ____________ ____________	Stamped with various punch patterns to create attractive designs; usually made from aluminum plate and available in many lively colors	Excellent	Return air openings, shelf work, and many ornamental and decorative applictions

TEST

5. State six safety rules for handling large sheets of metal.

   a. ______________________________

   ____

   b. ______________________________

   ____

   c. ______________________________

   ____

   d. ______________________________

   ____

   e. ______________________________

   ____

   f. ______________________________

   ____

(NOTE: Test items 6 and 7 are the assignment and job sheets. They are an important part of this test. If they have not been completed, check with your instructor.)

6. Identify metals by sight and feel.
7. Demonstrate the ability to lift and move a large sheet of metal according to safety standards.

SHEET METAL MATERIALS
UNIT I

ANSWERS TO TEST

1. a. 4
   b. 2
   c. 5
   d. 7
   e. 1
   f. 3
   g. 6
   h. 9
   i. 8

2. a. 1
   b. 3
   c. 7
   d. 5
   e. 8
   f. 6
   g. 4
   h. 2

3. a. Hot-rolled metal dipped in hot galvanneal
   b. Stainlesss steel
   c. The best of all metals
   d. Sign work, roof metals, and general commercial construction

4. a. Brass
   b. Copper
   c. Zinc
   d. Expanded metal
   e. Decorative metal

5. Answer should include any six of the following.

   a. Know the exact area to which the sheet will be moved
   b. Have another student or co-worker help; *never* attempt to move a large sheet of metal by yourself
   c. Use locking pliers as handles; adjust both sets of pliers to proper locking pressure before starting to lift or move the sheet
   d. Get a firm grip on the metal sheet; *do not* attempt to move until you're sure the sheet will not slip
   e. Move sheet so that locking pliers can be placed at each end of the sheet to provide a center of balance
   f. Clamp locking pliers into position on each end of the sheet
   g. Lift sheet to a safe distance off the floor, and with both workers on the same side of the sheet, carry it to the work area
   h. Place the sheet down slowly or secure it in the work area before releasing the locking pliers
   i. After cutting the proper working size, return metal to rack to ensure that fellow workers are not injured by metal protruding over edge of work bench

6. Evaluated to the satisfation of the instructor.

7. Performance skills evaluated to the satisfaction of the instructor.

SHEET METAL TOOLS
UNIT II

UNIT OBJECTIVE

After completing this unit, the student should be able to identify and explain the use of sheet metal tools. The student will show this ability by completing the assignment sheets and the unit test with a minimum score of 80 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match terms associated with sheet metal tools to their definitions.
2. Match types of measuring tools to their uses.
3. Match types of dividers to their uses.
4. Match types of squares to their uses.
5. Distinguish between a bevel protractor and a steel swinging-blade protractor.
6. Match types of sheet metal snips to their uses.
7. Match types of punches to their uses.
8. Match types of hammers to their uses.
9. Distinguish between a standard screwdriver and a Phillips screwdriver.
10. Match types of pliers to their uses.
11. Match types of metal marking devices to their uses.
12. Match types of metal gauges to their uses.
13. Match types of miscellaneous hand tools to their uses.
14. Match terms associated with machine tools to their definitions.
15. Match types of bench tools to their uses.
16. Match types of portable power tools to their uses.
17. Match types of manual and power-operated floor tools to their uses.
18. Use a circumference rule to perform measuring activities.
19. Identify sheet metal hand tools.

SHEET METAL TOOLS
UNIT II

SUGGESTED ACTIVITIES

I. Unit contents

   A. Objective sheet

   B. Suggested activities

   C. Information sheet

   D. Assignment sheets

      1. Assignment Sheet #1 — Use a Circumference Rule to Perform Measuring Activities

      2. Assignment Sheet #2 — Identify Sheet Metal Hand Tools

   E. Answers to assignment sheets

   F. Test

   G. Answers to test

II. Instructor's guide

   A. Review unit and plan presentation.

   B. Obtain materials to supplement unit.

      1. Samples of as many tools as possible

      2. Tool catalogs

   C. Introduce unit to students.

      - Have students look through tool catalogs.

      - Discuss hand tools, pointing out the importance of buying good grades of tools. Tell students that quality, not price, should be their main concern when purchasing tools.

   D. Provide students with objective sheet.

   E. Discuss unit and specific objectives, emphasizing the care and safe use of hand tools.

   F. Provide students with information and assignment sheets.

SUGGESTED ACTIVITIES

G. Discuss information and assignment sheets.

1. Use Information Sheet, Section I, to discuss terms and definitions associated with sheet metal hand tools.
    - Discuss or demonstrate terms that may be unfamiliar to students.
    - Have students review terms.
2. Use Information Sheet, Section II, to discuss types of measuring tools and their uses.
    - Display a sample of each measuring tool discussed in this section of the information sheet. Discuss proper use of each tool and allow students to examine and become familiar with each one.
    - Stress the importance of proper care of measuring tools; explain that improper care can cause inaccurate measurements.
    - Have students discuss and complete Assignment Sheet #1.
3. Use Information Sheet, Section III, to discuss types of dividers and their uses.
    - Display a sample of each type of divider. Discuss proper use of each divider and allow students to examine and become familiar with each one.
    - Demonstrate procedures for accurately setting the dividers, then demonstrate the use of each one.
    - Intentionally set the trammel points incorrectly and demonstrate what can happen when they are set incorrectly; reset, then show the difference in the circle or arc.
4. Use Information Sheet, Section IV, to discuss types of squares and their uses.
    - Display a sample of each type of square discussed in this section. Discuss proper use of each square, and allow students to examine and become familiar with each type of square.
    - Caution students about proper handling and use of the square; damaged squares have no place in a tool box.
5. Use Information Sheet, Section V, to discuss types of protractors.
    - Display a sample of each type of protractor discussed in this section. Discuss proper use, and allow students to examine the protactors.

SUGGESTED ACTIVITIES

- Caution students about careful handling of protactors. Carefully handled protractors are accurate instruments and should be treated as such.

- Have students demonstrate the proper use of protractors.

6. Use Information Sheet, Section VI, to discuss types of sheet metal snips and their uses.

   - Display a sample of each type of snips discussed in this section of the information sheet. Discuss proper use of each type of sheet metal snips, and allow students to examine and become familiar with each type.

   - Demonstrate cutting a straight line and left- and right-curved lines, then let the students practice each type of cut.

   - Caution students that mishandling of snips may damage or dull the jaws.

7. Use Information Sheet, Section VII, to discuss types of punches and their uses.

   - Display a sample of each type of punch discussed in this section of the information sheet. Discuss proper use of each punch and allow students to examine these punches.

   - Demonstrate the use of each punch.

   - Caution students not to use hand punches on too heavy gauge material.

8. Use Information Sheet, Section VIII, to discuss types of hammers and their uses.

   - Display a sample of each type of hammer discussed in this section of the information sheet. Discuss the proper use of each hammer, and allow students to handle hammers and become familiar with them.

   - Tell students to use the correct hammer for the job it was designed for. Caution students against hitting two hammer faces together.

9. Use Information Sheet, Section IX, to discuss basic types of screwdrivers and their uses.

   - Display a sample of each type of screwdriver discussed in this section of the information sheet. Allow students to examine the screwdrivers.

SUGGESTED ACTIVITIES

- Point out that screwdrivers must fit the screw slots properly. If the screwdriver is too large it will damage the screwhead and if it is too small it will damage the screwdriver.

- Provide each student with a piece of hardwood and some screws. Have the students select the correct screwdriver to drive each screw; and have them practice driving the screws. Also allow students to practice with metal screws in metal.

- Demonstrate the technique of using pilot holes to aid in driving screws.

10. Use Information Sheet, Section X, to discuss types of pliers and their uses.

- Display a sample of each type of pliers discussed in this section of the information sheet. Discuss proper use of pliers and allow students to examine pliers.

- Remind students to use the correct tool for the job. Pliers should not be used as wrenches to adjust nuts and bolts. Point out that nuts and bolts are frequently ruined when someone uses pliers instead of a wrench.

- Have students make a list of correct uses for pliers. Check to see who has the most *correct* uses.

11. Use Information Sheet, Section XI, to discuss types of metal marking devices and their uses.

- Display a sample of each type of metal marking device discussed in this section of the information sheet. Discuss proper use of each type.

- Demonstrate proper use of each type of marker, then have students demonstrate the proper use.

12. Use Information Sheet, Section XII, to discuss types of metal gauges and their uses.

- Display a sample of each type of metal gauge discussed in this section of the information sheet. Discuss proper use of each type.

- Have several samples of different gauge metals and wire on hand so that you can demonstrate the use of the gauges.

- Have each student demonstrate the use of each gauge.

SUGGESTED ACTIVITIES

13. Use Information Sheet, Section XIII, to discuss types of miscellaneous hand tools and their uses.

    - Display a sample of each miscellanous tool discussed in this section of the information sheet. Discuss proper use of each tool and allow students to examine each tool.
    - Arrange for a field trip to a sheet metal shop where students may observe the tools being used.
    - Demonstrate the use of each tool and then have each student demonstrate their use.
    - Remind students of proper care and safe use of hand tools.
    - Have students complete Assignment Sheet #2.

14. Use Information Sheet, Section XIV, to discuss terms and definitions associated with machine tools.

    - Discuss or demonstrate terms that may be unfamiliar to students.
    - Have students review terms.
    - Have students review sections in the safety unit of *Fundamentals of Construction* pertaining to machine and power tools.

15. Use Information Sheet, Section XV, to discuss types of bench tools and their uses.

    - Display samples of the bench tools available to you as they are discussed.
    - Demonstrate the use and safety requirements for each tool as it is used.
    - Have students demonstrate the use and safety requirements for each tool.
    - Post at each bench tool safety rules pertaining to that particular bench tool.
    - Make a display of accident report forms and safety posters.

16. Use Information Sheet, Section XVI, to discuss types and uses of portable power tools.

    - Emphasize the convenience of power tools while stressing the fact that the use of power tools places on the students an even greater responsibility to be careful.

SUGGESTED ACTIVITIES

- Display samples of as many power tools as are available to you as they are discussed.
- Demonstrate the use and safety requirements for each tool as it is used.
- Give students the opportunity to use each of the tools, but only while you are supervising.
- Invite sheet metal workers who have been injured by power tools to talk to the class about their accidents.

17. Use Information Sheet, Section XVII, to discuss types and uses of manual and power-operated floor tools.

    - Display samples of as many floor tools as are available to you as they are discussed.
    - Demonstrate the use and safety requirements for each tool as it is used.
    - Give students the opportunity to use each of the tools, but only while you are supervising.
    - Discuss proper care of all tools in general.
    - Discuss safety, care, and uses of all tools in accordance with your plan of presentation.

H. Give test.

I. Critique test and discuss in class.

J. Reteach and retest as necessary.

K. Complete appropriate section of competency profiles.

(NOTE: A master of the competency profile for this book is provided at the front of the instructor edition. You may duplicate the profile and distribute it to students as needed.)

III. Unit reference — Jones, Leonard and Morse, Otto. *Sheet Metal Basics*.. Stillwater, Oklahoma: Mid-America Vocational Curriculum Consortium, Inc., 1983.

SHEET METAL TOOLS
UNIT II

INFORMATION SHEET

I. Terms and definitions associated with sheet metal tools

A. **Gauge** — Thickness of sheet metal or wire; also a device to measure that thickness

B. **Burrs or fishhooks** — Irregular edges on sheet metal that turn up and roll into a fishhook shape resulting from improper use of cutting snips

CAUTION

Handle sheet metal carefully, as burrs and fishhooks can easily become lodged in fingers, causing a painful injury.

C. **Scribe** — To scratch on a piece of metal with another piece of metal to make a line or a pattern; also a device for scratching on metal

D. **Waste** — Unusable metal remaining after a pattern has been cut

(NOTE: Waste is also known as *scrap*, and sometimes used in the expression "waste the metal" meaning to place it in the scrap pile.)

E. **Cutting technique** — The use of hand snips with such a degree of skill that cut edges are left smooth and clean and free of burrs or fishhooks

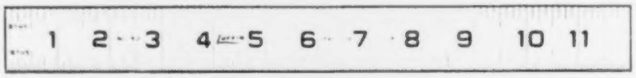
II. Types of measuring tools and their uses (Figures 1-4)

(NOTE: The hand tools discussed in Sections II through XIII are furnished by the sheet metal worker.)

A. Steel rules — Used for measuring linear distances; graduated to $^1/_{16}$-inch; usually 24 inches, 36 inches, or 48 inches long; for critical measurements, some rules are graduated to $^1/_{64}$ inch

EXAMPLE:

FIGURE 1

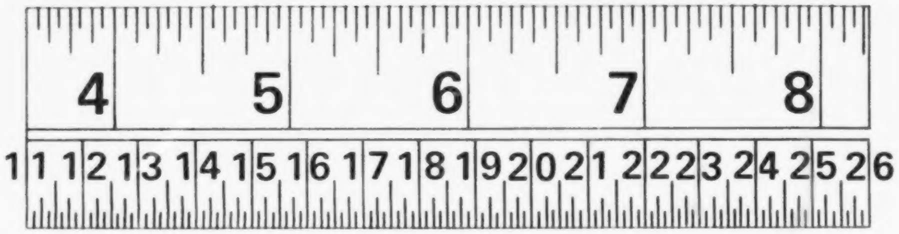


B. Circumference rules — Used to find the circumference of a circle when the diameter is known or the diameter of a circle when the circumference is known; also used as a straightedge and for other activities in layout work

INFORMATION SHEET

EXAMPLE:

FIGURE 2

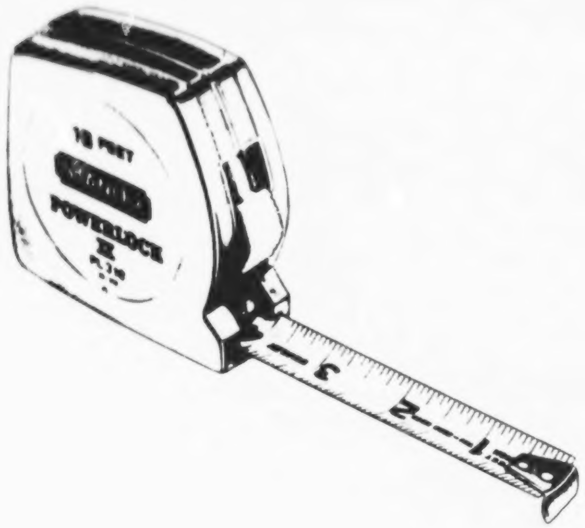

4
5
6
7
8
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26

C. Retractable steel tape rules — Take up little space, are handy to carry and easy to use; available in lengths from 6 feet to 25 feet and graduated to $^{1}/_{16}$ inch

(NOTE: Some retractable rules have the lower or opposite edge graduated to $^{1}/_{32}$ inch.)

EXAMPLE:

FIGURE 3

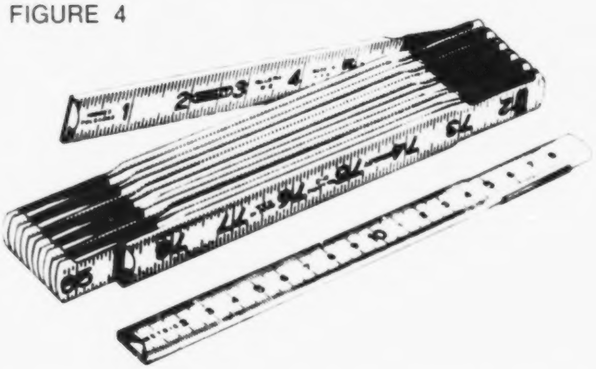

16 FEET
POWERLOCK
II
3
2
1

INFORMATION SHEET

D. Inside-reading folding rules — Commonly used in sheet metal work; usually 6 feet long and graduated to $^1/_{16}$ inch

EXAMPLE:

FIGURE 4

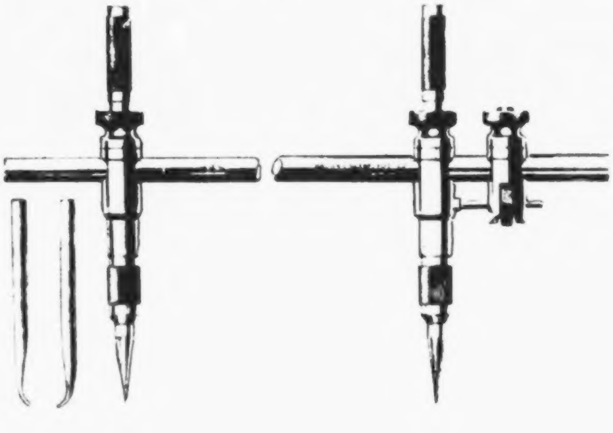


III. Types of dividers and their uses (Figures 5 and 6)

A. Trammel points — Used to construct large circles and arcs

EXAMPLE:

FIGURE 5

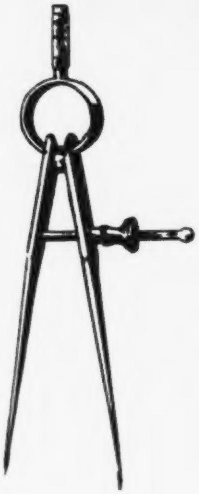


INFORMATION SHEET

B. Wing dividers — Used to construct small circles and arcs and to transfer dimensions

EXAMPLE:

FIGURE 6



IV. Types of squares and their uses (Figures 7-9)

A. Try squares — Used for accuracy in layout work; blades are available in 6-inch, 8-inch, 10-inch, and 12-inch lengths

EXAMPLE:

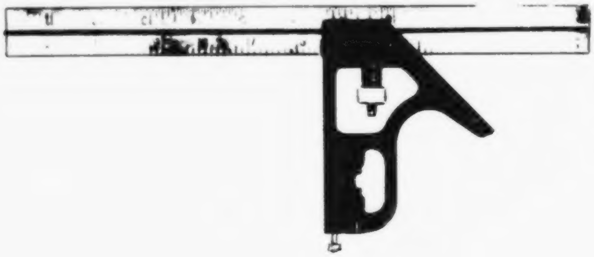
FIGURE 7

INFORMATION SHEET

B. Combination squares — Used for layout accuracy with 45° and 90° angles

EXAMPLE:

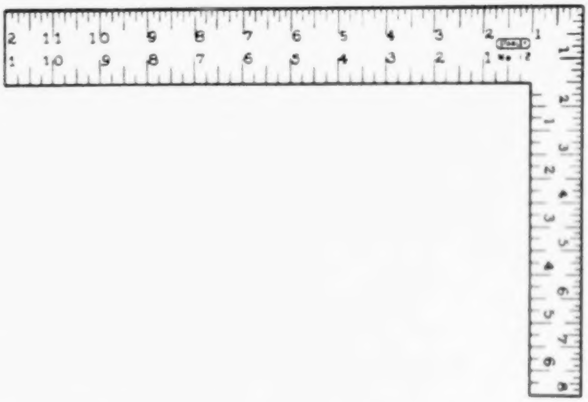
FIGURE 8



C. Framing squares — Used in layout work for accuracy because all layout must start from a square corner

EXAMPLE:

FIGURE 9

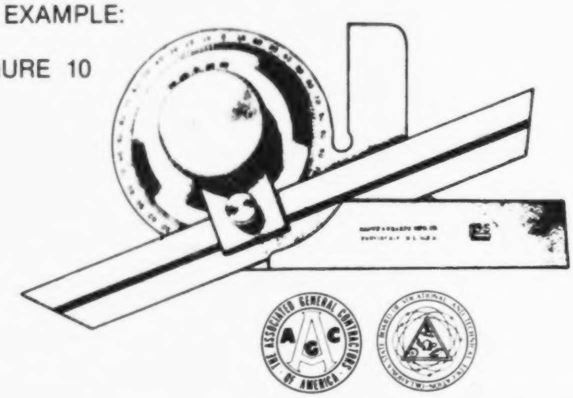


V. Types of protractors (Figures 10 and 11)

A. Bevel protractor — Used to find or construct angles of different degrees

EXAMPLE:

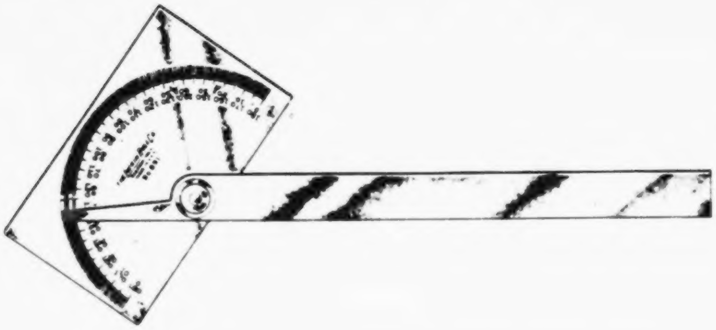
FIGURE 10



B. Steel swinging-blade protractor — Used to find or construct angles of different degrees; lighter and easy to carry in a tool box

EXAMPLE:

FIGURE 11



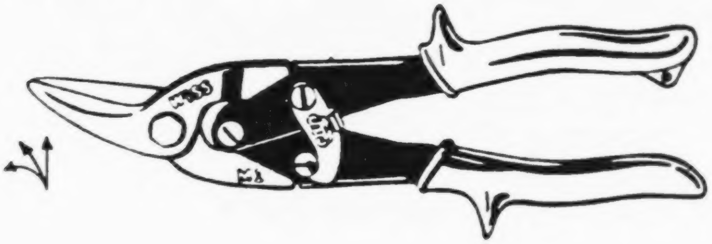
VI. Types of sheet metal snips and their uses (Figures 12-19)

(NOTE: Do not use snips to cut wire or welding rods, and when snips are marked "stainless steel" use them *only* for cutting stainless.)

A. Left cut — Cuts to the left around curves and 90° corners

EXAMPLE:

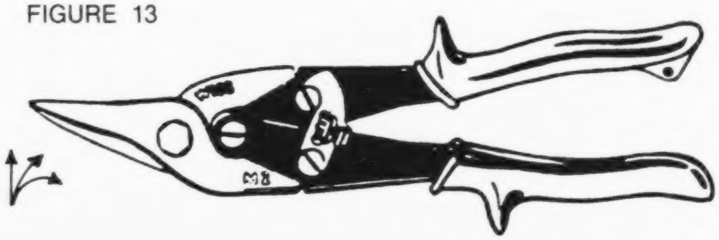
FIGURE 12



B. Right cut — Cuts to the right around curves and 90° corners

EXAMPLE:

FIGURE 13

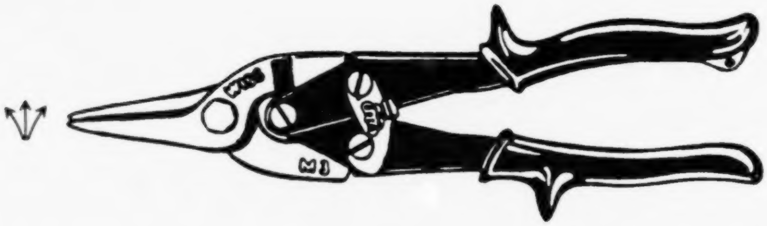


INFORMATION SHEET

C. Straight cut — Cuts straight lines or curves; one style has very short blades for special cutting needs

EXAMPLE:

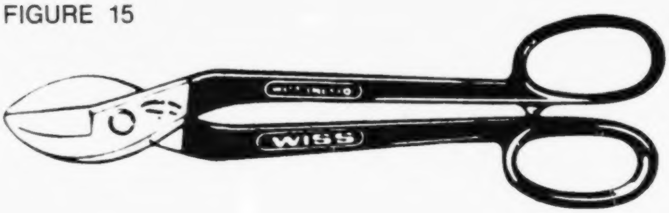
FIGURE 14



D. Bulldog — Heavy duty snips used for all general cuts and thicker metals

EXAMPLE:

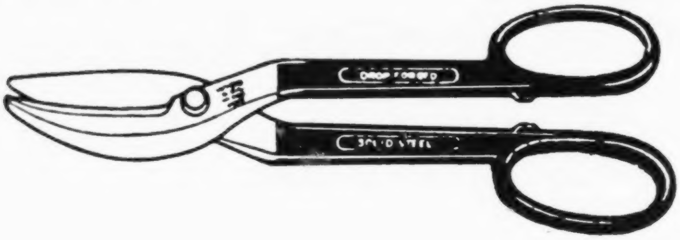
FIGURE 15



E. Circular — For cutting inside circles and metal close to an obstacle

EXAMPLE:

FIGURE 16

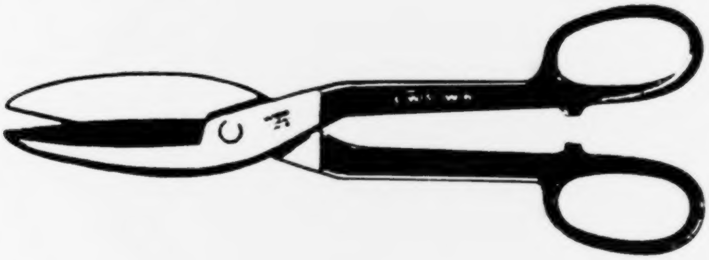


INFORMATION SHEET

F. Straight blade — Best for cutting straight lines

EXAMPLE:

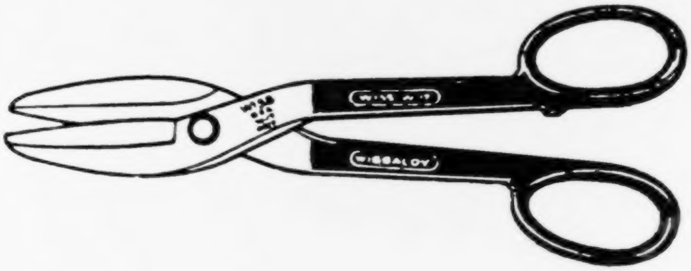
FIGURE 17



G. Combination blade — Will cut curves by letting the metal slide over the top blade with ease, and will also cut straight

EXAMPLE:

FIGURE 18

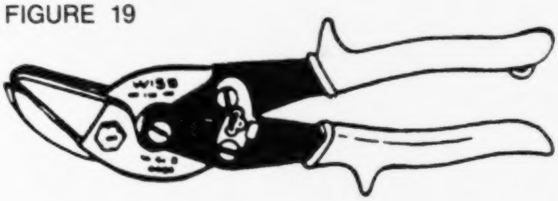


H. Double cut — Specifically designed to cut 1/8-inch wide slit in preformed metal duct

(NOTE: Double cut snips minimize waste and time, and although normally used to cut round duct, can also be used on square or rectangular duct.)

EXAMPLE:

FIGURE 19



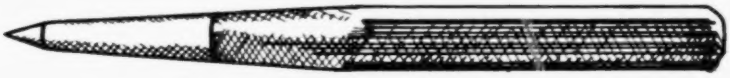
INFORMATION SHEET

VII. Types of punches and their uses (Figures 20-23)

A. Prick punch — Used to make small dents or establishing points for trammel points and wing dividers; point is ground to approximately 30°

EXAMPLE:

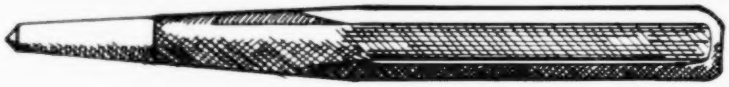
FIGURE 20



B. Center punch — Used for marking the location point and the center of holes to be drilled; the point is ground to approximately 90°

EXAMPLE:

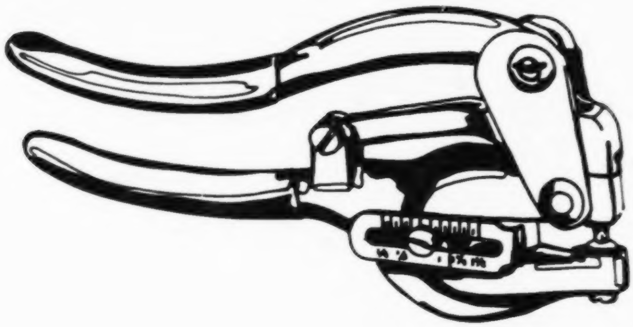
FIGURE 21



C. Tinner's hand punch — Used to punch small holes in light gauge metal; punches and dies range in size from 1/16 inch to 9/32 inch, and are easily changed

EXAMPLE:

FIGURE 22

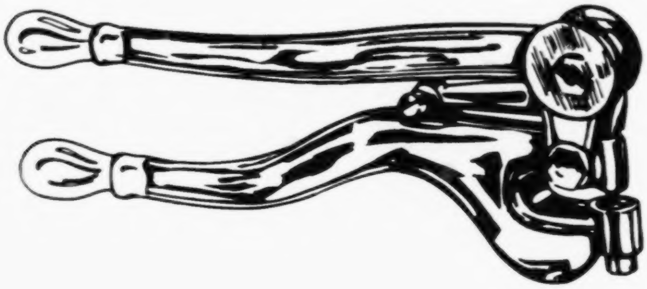


INFORMATION SHEET

D. Iron hand punch — Used on heavier gauge material; punches and dies range from 1/16 inch to 1/2 inch, and are easily changed

EXAMPLE:

FIGURE 23

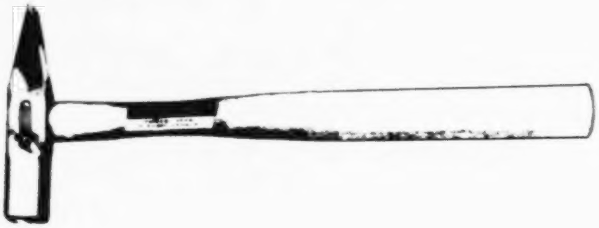


VIII. Types of hammers and their uses (Figures 24-29)

A. Riveting hammer — Has a slightly curved, square face and beveled edges to prevent marking metal as rivets are set

EXAMPLE:

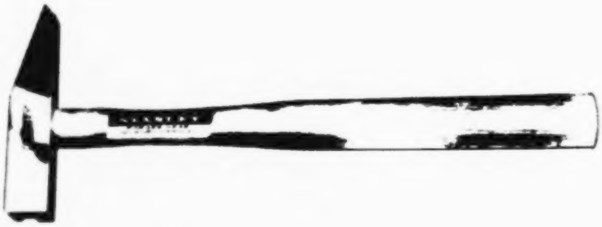
FIGURE 24



B. Setting hammer — Has a square, flat face and flat sides for closing up a Pittsburgh lock

EXAMPLE:

FIGURE 25

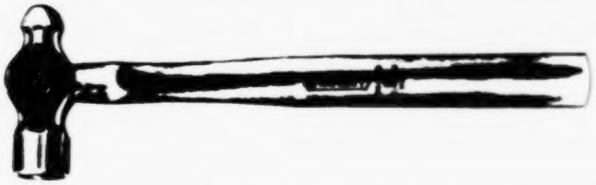


INFORMATION SHEET

C. Ball peen hammer — General purpose hammer with a curved face and round head

EXAMPLE:

FIGURE 26



D. Nail hammer — Not considered a sheet metal tool, but is found and used in almost all sheet metal shops

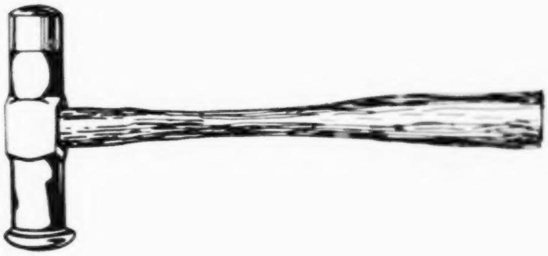
EXAMPLE:

FIGURE 27

E. Body or raising hammer — Used mostly as a finish tool, in cornice work, and in stainless steel work

EXAMPLE:

FIGURE 28



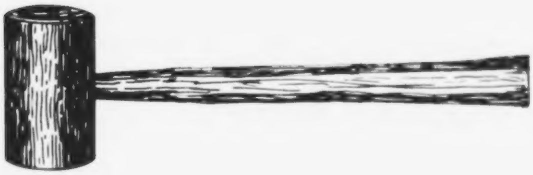
INFORMATION SHEET

F. Mallet — Made of good hickory or rawhide and used where a metal hammer would dent or damage material

(NOTE: Only a mallet should be used on a brake.)

EXAMPLE:

FIGURE 29

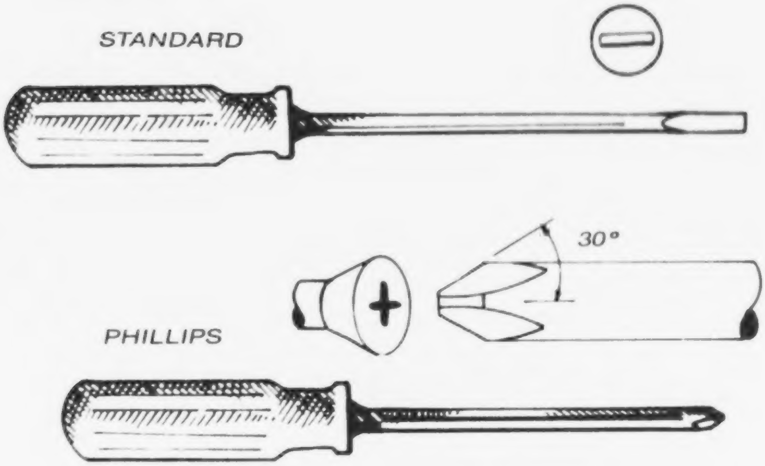


IX. Basic types of screwdrivers and their uses (Figure 30)

A. Standard — Used on bolts and screws with straight-slot heads

B. Phillips — Used on bolts and screws with cross-slot heads

FIGURE 30



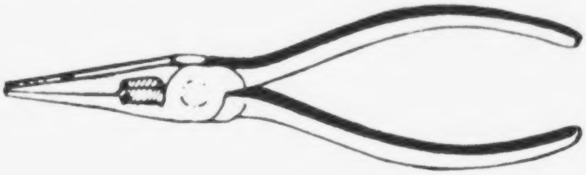
INFORMATION SHEET

X. Types of pliers and their uses (Figures 31-34)

A. Long nose pliers — Long narrow nose for deeper reach into work area

EXAMPLE:

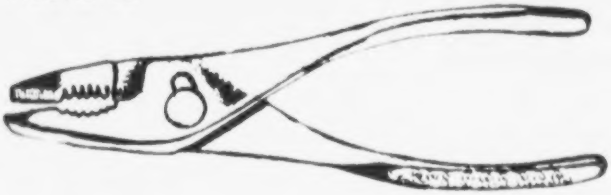
FIGURE 31



B. Combination pliers — For holding an object that is difficult to hold with one's hands; should *not* be used as a wrench for removing nuts

EXAMPLE:

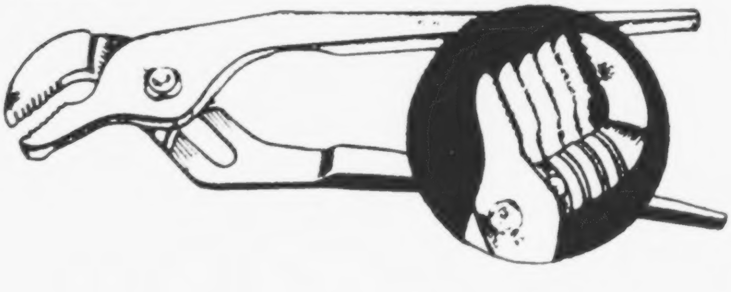
FIGURE 32



C. Adjustable pliers — Jaws are positioned and locked into place by engaging tongue in proper groove; a series of channels give wide range of jaw openings; jaws should not slip, even under heavy pressure

EXAMPLE:

FIGURE 33

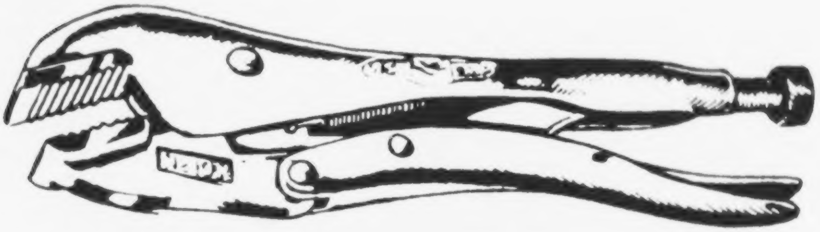


INFORMATION SHEET

D. Locking pliers — Pliers adjust easily to lock at any size with desired amount of pressure; release lever opens jaws; can also be used as nonlocking pliers

EXAMPLE:

FIGURE 34



XI. Metal marking devices (Figures 35 and 36)

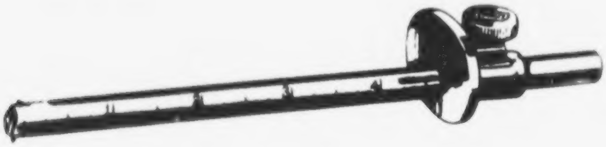
CAUTION

Metal-marking devices can cut your hand easily, so use them with care.

A. Scratch gage — Used to scribe lines on metal using the edge of the metal as a straightedge, but can be used in many ways depending on type

EXAMPLE:

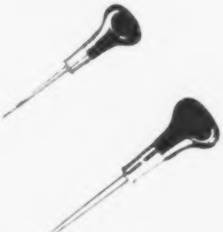
FIGURE 35



B. Scratch awl — Used to scribe lines on metal in sheet metal layout; used with a guide

EXAMPLE:

FIGURE 36



INFORMATION SHEET

XII. Types of metal gauges and their uses (Figures 37 and 38)

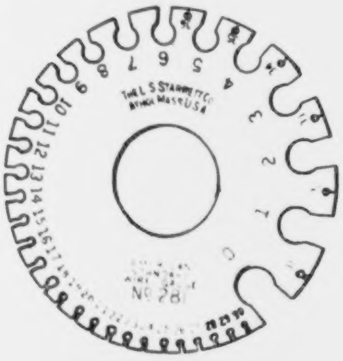
A. American standard wire gauge — Used for measuring the thickness of sheets and wire made of nonferrous metals such as copper, brass, and aluminum

(NOTE: The American standard wire gauge is sometimes called a *Brown and Sharpe* gauge.)

B. U.S. standard gauge — Used for measuring uncoated sheet, plate iron and steel; based on weights in ounces per square foot

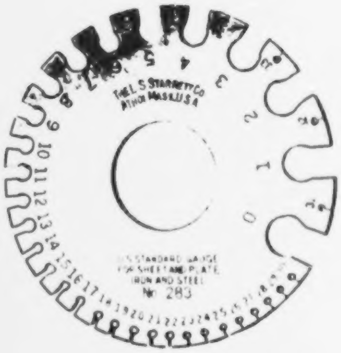
(NOTE: There are specialty gauges such as the English standard wire gauge, but the American and U.S. standard gauges are most frequently used in sheet metal work.)

FIGURE 37


THE L.S. STARRETT CO
ATHOL MASS U.S.A
No 281
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17

AMERICAN STANDARD WIRE GAUGE

FIGURE 38


THE L.S. STARRETT CO
ATHOL MASS U.S.A
U.S. STANDARD GAUGE
FOR SHEET AND PLATE
IRON AND STEEL
No 283
0
1
2
3
4
5
9
10
11
12
13
14
15
16
17

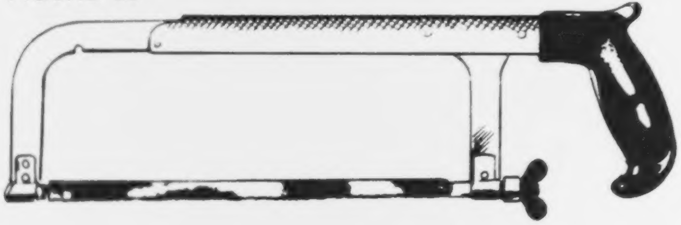
U.S. STANDARD GAUGE

XIII. Types of miscellanous hand tools and their uses (Figures 39-54)

A. Hacksaw — Used to cut various types of metal

EXAMPLE:

FIGURE 39

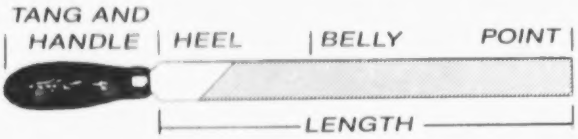


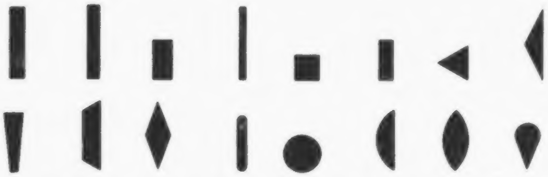
INFORMATION SHEET

B. File — Used to remove burrs, to square the ends of band iron, and to straighten uneven edges

EXAMPLE:

FIGURE 40


TANG AND HANDLE
HEEL
BELLY
POINT
LENGTH

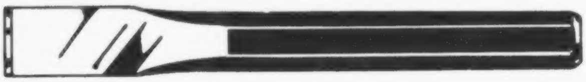


CROSS-SECTIONS OF FILE SHAPES

C. Flat cold chisel — Used for cutting rivets, bolts, and metal; point is ground to 70°

EXAMPLE:

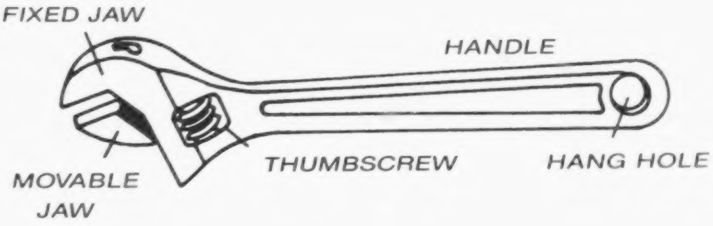
FIGURE 41



D. Adjustable wrench — Designed to fit various size nuts within its capacity; comes in various sizes

EXAMPLE:

FIGURE 42

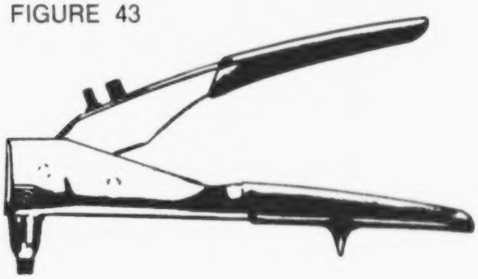

FIXED JAW
HANDLE
THUMBSCREW
HANG HOLE
MOVABLE JAW

INFORMATION SHEET

E. Pop-rivet gun — Rivet-setting tool designed for rivets to be inserted and set from one side in aluminum, steel, and copper; rivets range in size from 1/8 inch to 1/4 inch

EXAMPLE:

FIGURE 43

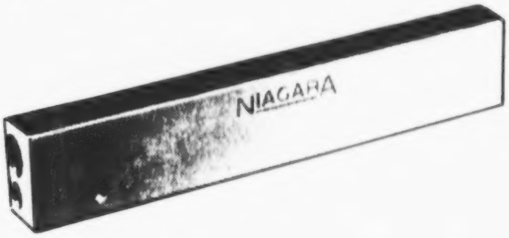


F. Rivet set — Made with a deep hole used to pull tinner's rivets through metal, and a cup-shaped hole to set the rivets; a hole in the side is for releasing burrs

(NOTE: There are various size rivet sets for various size rivets, and the tool is also used for setting down a Pittsburgh lock.)

EXAMPLE:

FIGURE 44



G. Multiple-use dolly bar — Used to buck the head of a rivet as it is pulled together

EXAMPLE:

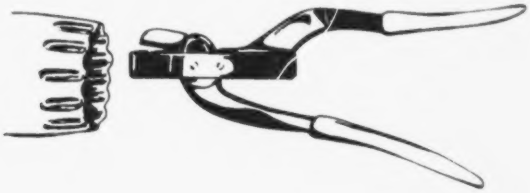
FIGURE 45

INFORMATION SHEET

H. Pipe crimper — Used to reduce the size of the end of a pipe; permits one end of a pipe to fit inside another piece that is the same size

EXAMPLE:

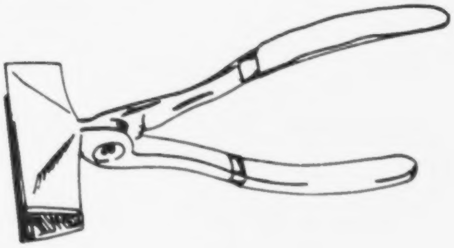
FIGURE 46



I. Hand seamer — Makes bends on light gauge metal which is inconvenient to bend on a brake

EXAMPLE:

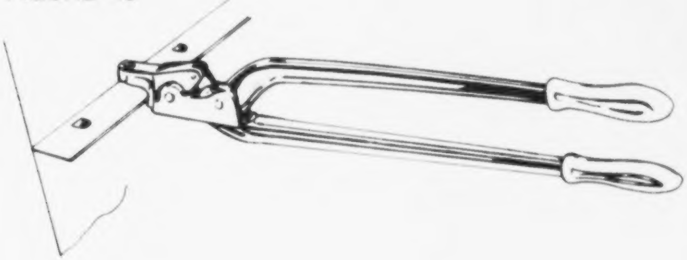
FIGURE 47



J. Clip punch — An efficient tool for fastening seams in duct work; an "ear" is cut and bent out to be hammered tight with hammer

EXAMPLE:

FIGURE 48

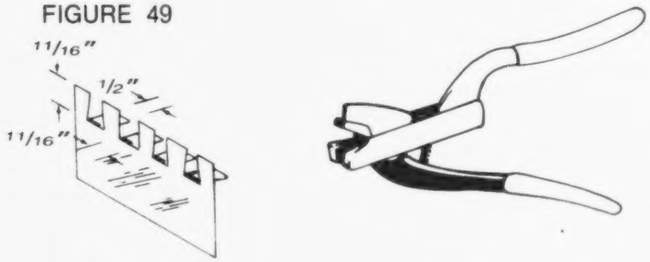


INFORMATION SHEET

K. Dovetailer — Used to cut clips for joining round pipe to a flat or round piece of metal

EXAMPLE:

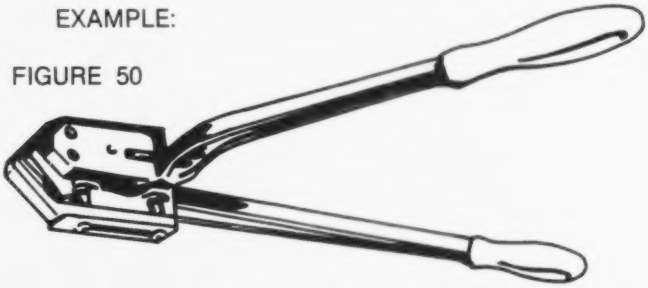
FIGURE 49



L. Hand notcher — Used for notching ductwork corners for "S" and drive clips

EXAMPLE:

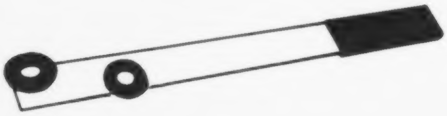
FIGURE 50



M. Duct stretcher — Used to hook into drive cleats in ductwork to pull the duct together

EXAMPLE:

FIGURE 51

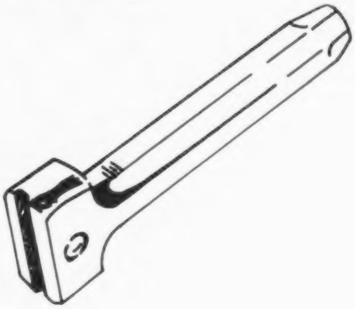


INFORMATION SHEET

N. Hand groover — Tool that is struck with a hammer to form hammer-lock pipe seams by hand; also used in completing Pittsburgh seams

EXAMPLE:

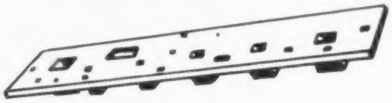
FIGURE 52



O. Stake plate — Steel plate with various size holes designed to hold the tapered end of stakes firmly so the stakes can be used for forming metal

EXAMPLE:

FIGURE 53

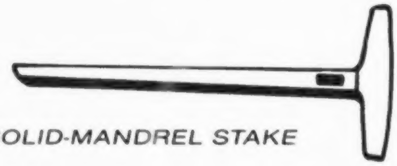


INFORMATION SHEET

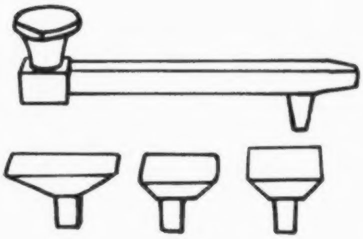
P. Stakes — Shaping tools used with hand tools to complete numerous sheet metal operations such as tube forming, taper forming, flanging, side and circular seaming, box and pail seaming, riveting, and grooving

EXAMPLES:

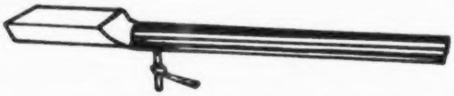
FIGURE 54



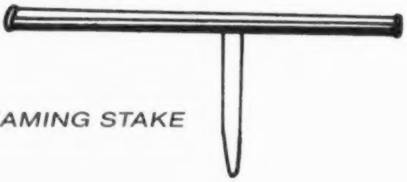
SOLID-MANDREL STAKE



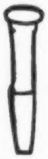
DOUBLE-SEAMING STAKE WITH FOUR HEADS



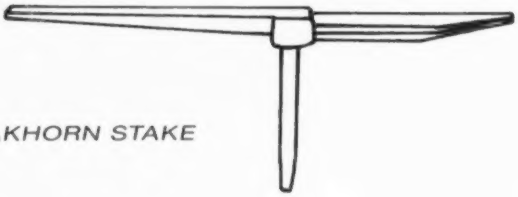
HOLLOW-MANDREL STAKE



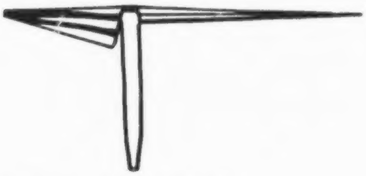
DOUBLE-SEAMING STAKE



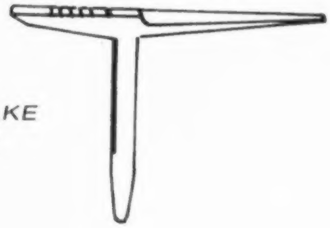
ROUND-HEAD STAKE



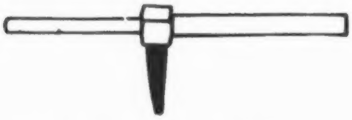
BEAKHORN STAKE



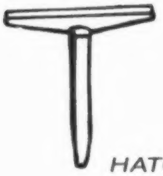
BLOWHORN STAKE



CREASING STAKE WITH HORN



CONDUCTOR STAKE



HATCHET STAKE

INFORMATION SHEET

XIV. Terms and definitions associated with machine tools

A. **Bench tools** — Small, hand-operated tools generally anchored to a bench and used for one or more operations on cylindrical projects

B. **Portable power tools** — Small, electrically or air-operated tools that can be comfortably moved from job to job

C. **Manual and power-operated floor tools** — Medium to large tools that are usually secured in a permanent position for forming and working with sheet metal

D. **Brakes** — Machines for making straight line bends to specified angles for rectangular components

E. **Rolls** — Machines for making cylindrical components

F. **Stretchout** — The amount of material required to fabricate a given component not including seam or joint allowances

G. **Blocking out** — Cutting out by hand or on a square shear all the material required to complete a pattern

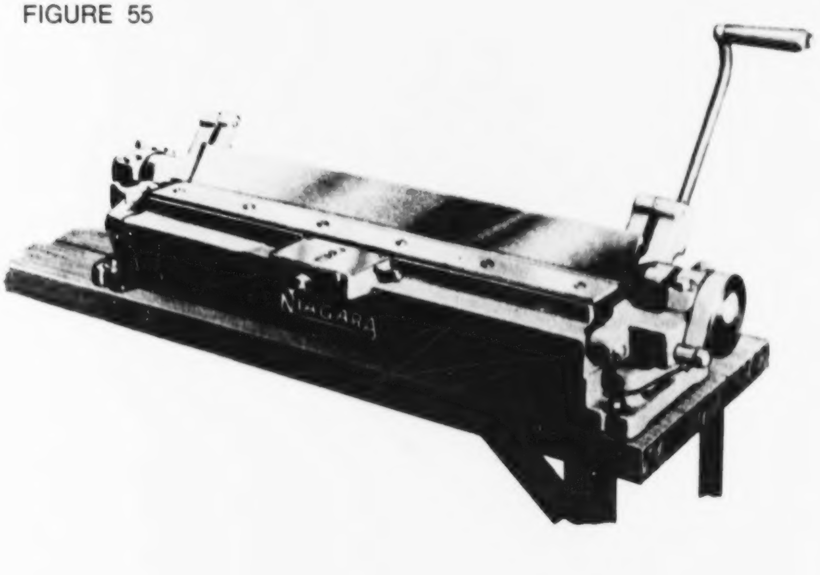
XV. Types of bench tools and their uses (Figures 55-68)

(NOTE: The bench and power tools discussed in Sections XV through XVII are furnished by the sheet metal shop.)

A. Adjustable-bar folder — For folding, bending, hemming, setting down, and making drive clips

EXAMPLE:

FIGURE 55

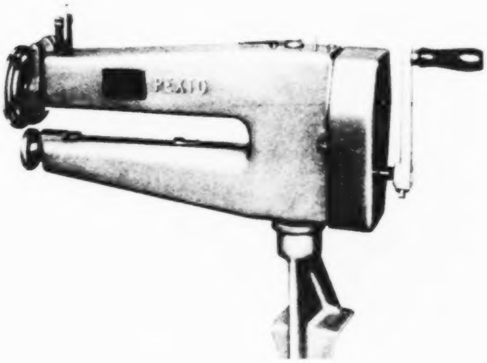


INFORMATION SHEET

B. Double seam machine — For double-seaming flat bottoms on straight or flared cylindrical articles

EXAMPLE:

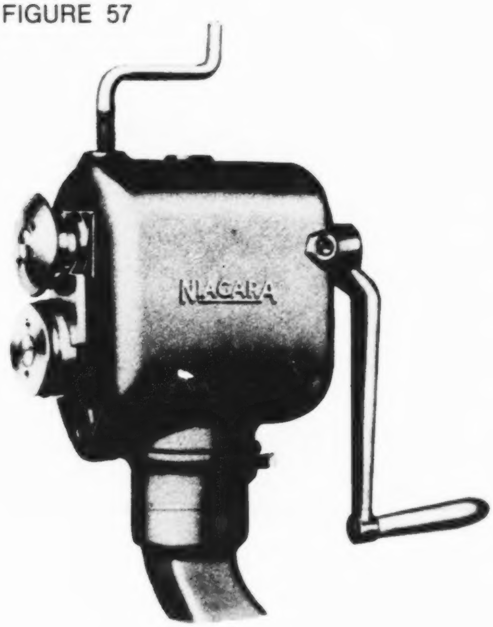
FIGURE 56



C. Burring machine — For turning edges on circular discs such as bucket bottoms and for turning edges for double-seaming cylindrically shaped projects

EXAMPLE:

FIGURE 57

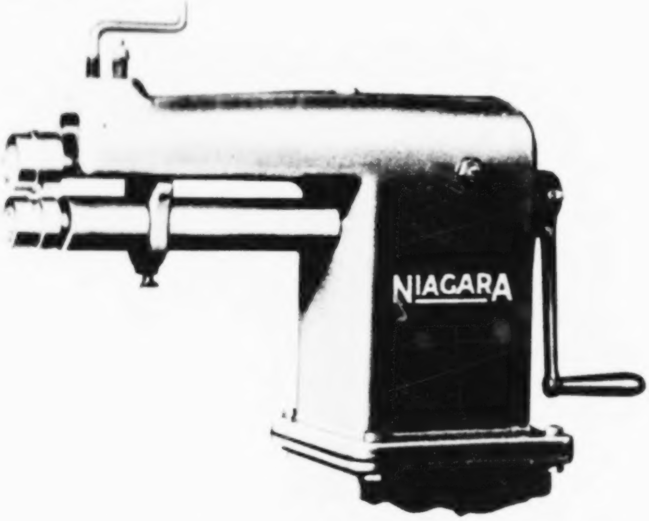


INFORMATION SHEET

D. Beading machine — For various beading operations with single and ogee rolls

EXAMPLE:

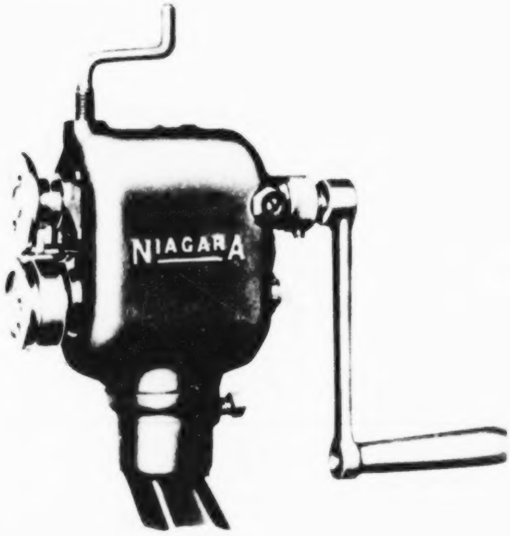
FIGURE 58



F. Turning machine — For making rounded edges for wiring operations on cylinders, and for double-seaming

EXAMPLE:

FIGURE 59

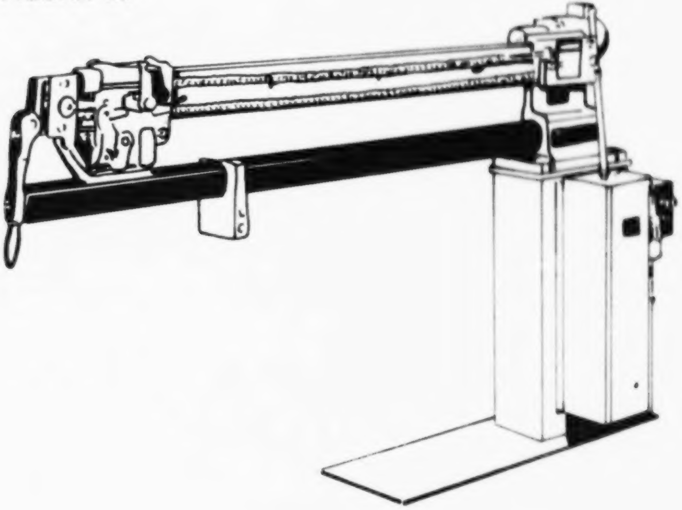


INFORMATION SHEET

F. Grooving machine — A specialized machine for grooving longitudinal seams in cylinders by grooving and flattening in one operation of the carriage

EXAMPLE:

FIGURE 60

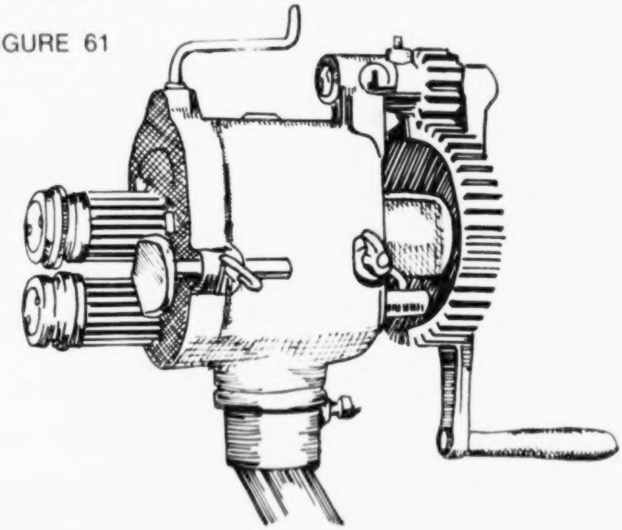


G. Crimping and beading machine — For crimping and beading the end of a cylinder

(NOTE: By changing the rolls, it will crimp or bead only.)

EXAMPLE:

FIGURE 61

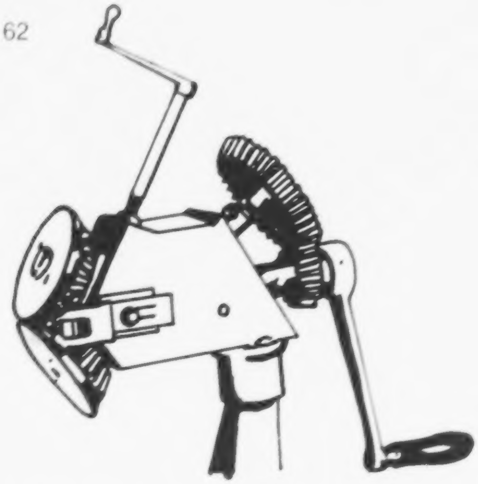


INFORMATION SHEET

H. Setting-down machine — For setting down seams on containers of various shapes

EXAMPLE:

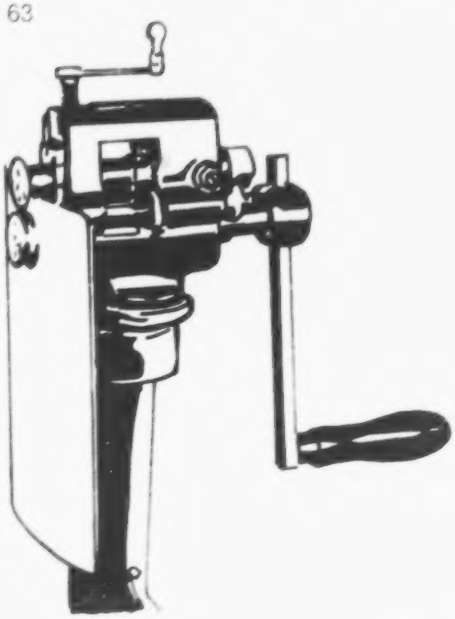
FIGURE 62



I. Elbow-edging machine — For turning the edges of elbow gores so the gores can be assembled as a complete elbow with tight or adjustable joints

EXAMPLE:

FIGURE 63

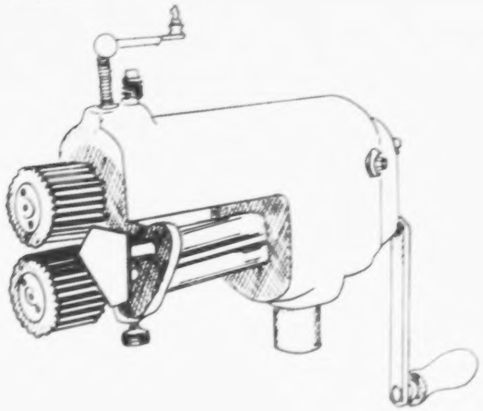


INFORMATION SHEET

J. Combination rotary machine — Has numerous interchangeable rolls to facilitate several different operations simply by changing to the desired set of rolls

EXAMPLE:

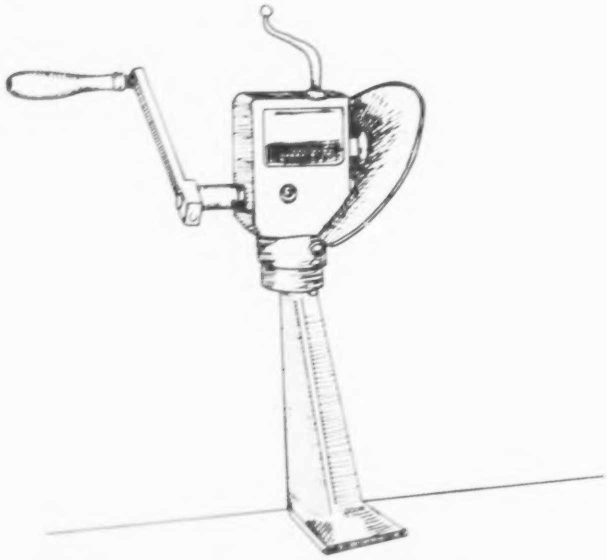
FIGURE 64



K. Easy edger — Turns perfect flanges on curved metal edges

EXAMPLE:

FIGURE 65

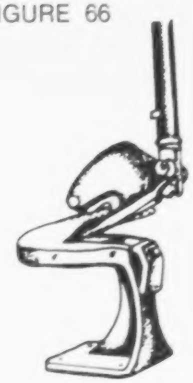


INFORMATION SHEET

L. Multi-purpose bench level shear — Throatless shear which will cut straight or curved lines without distortion in heavy to light metals

EXAMPLE:

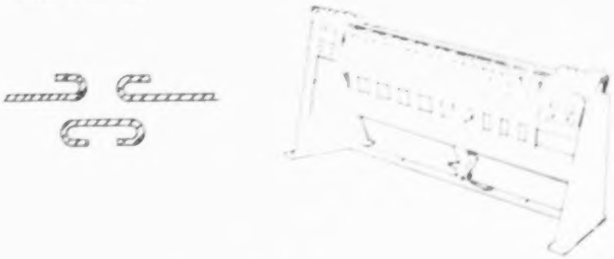
FIGURE 66



M. Cleat bender — A tool used to turn drives on preassembled duct

EXAMPLE:

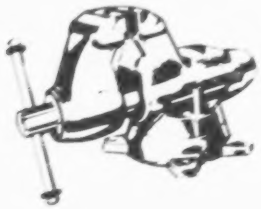
FIGURE 67



N. Bench vise — For clamping stock to be worked on; the swivel base type is the most common type

EXAMPLE:

FIGURE 68



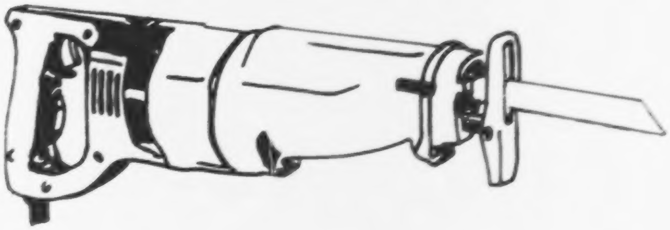
INFORMATION SHEET

XVI. Types of portable power tools and their uses (Figures 69-77)

A. Reciprocating saw — A portable electric keyhole saw with various types and sizes of blades for cutting wood, metal, plastics, and heavier steel

EXAMPLE:

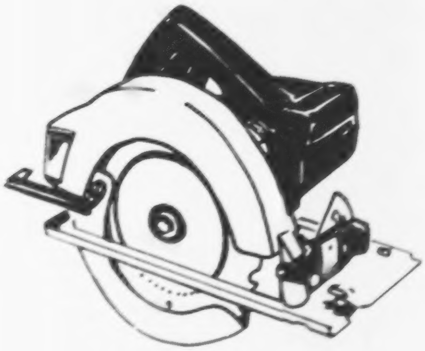
FIGURE 69



B. Circular saw — A general purpose saw used in the construction trades for cutting wood, metal, and plastics

EXAMPLE:

FIGURE 70

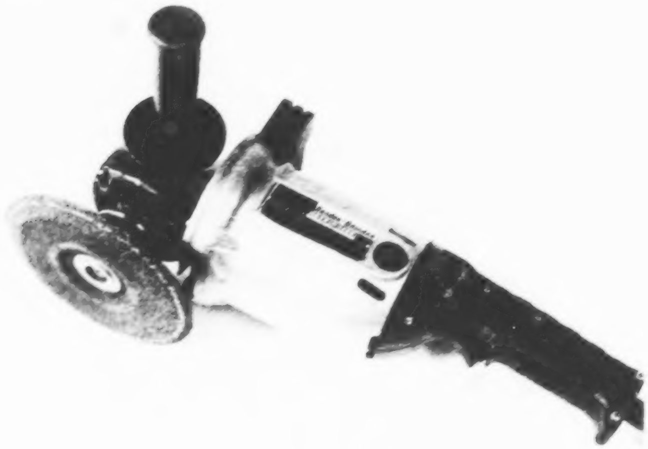


INFORMATION SHEET

C. Angle grinder — Generally used with attachments for cleaning joints after a welding process

EXAMPLE:

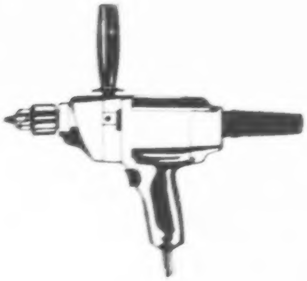
FIGURE 71



D. Hand drill — Generally used for light drilling jobs; comes in various types such as variable-speed, reversible, ¼-inch, ⅜-inch, and ½-inch capacities

EXAMPLE:

FIGURE 72

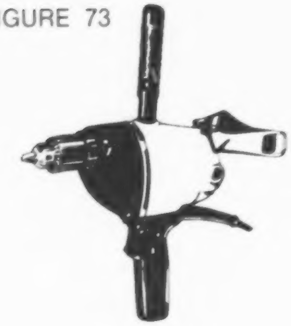


INFORMATION SHEET

E. Heavy-duty hand drill — Generally used for drilling heavy or thick materials; comes in various types such as variable-speed, reversible, 1/2-inch, 3/4-inch, 1 1/4-inch capacities

EXAMPLE:

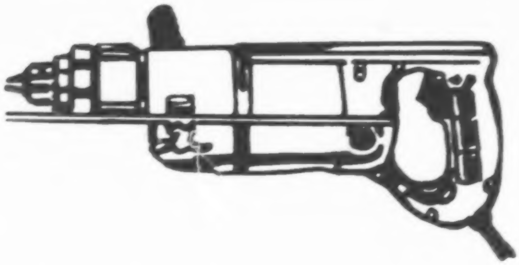
FIGURE 73



F. Hammer drill — A heavy-duty drill with a percussion bit for drilling through masonry, brick, and tile

EXAMPLE:

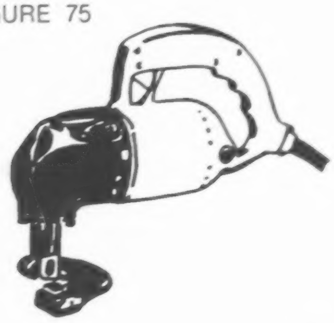
FIGURE 74



G. Unishear — A hand-held metal-cutting shear for heavy metals

EXAMPLE:

FIGURE 75

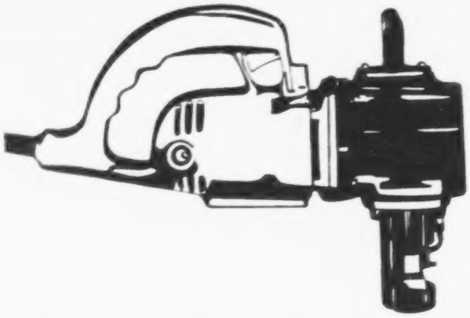


INFORMATION SHEET

H. Nibbler — Separates metal by punching 1/8-inch pieces out of the metal with a rapid punching to speed up pattern cutting with light to heavy gauge metals

EXAMPLE:

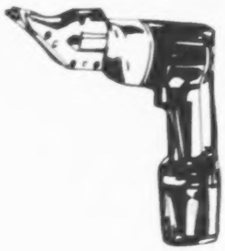
FIGURE 76



I. Power double cuts — For cutting a cylinder into two or more pieces with minimum waste and time

EXAMPLE:

FIGURE 77



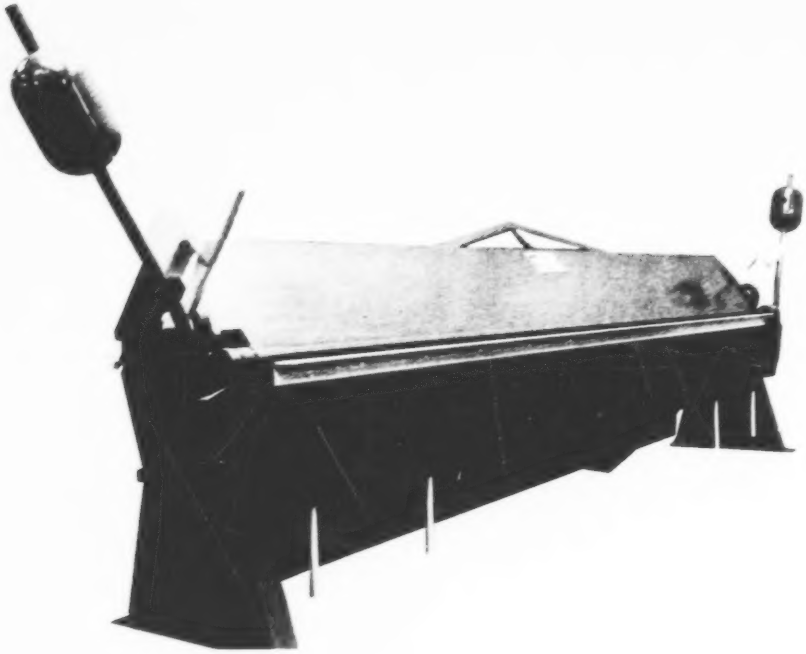
XVII. Types of manual and power-operated floor tools and their uses (Figures 78-94)

A. Hand brake — A machine used for bending or forming flat metal into various shapes; may be in 4-foot, 5-foot, 8-foot, 10-foot, or longer lengths

INFORMATION SHEET

EXAMPLE:

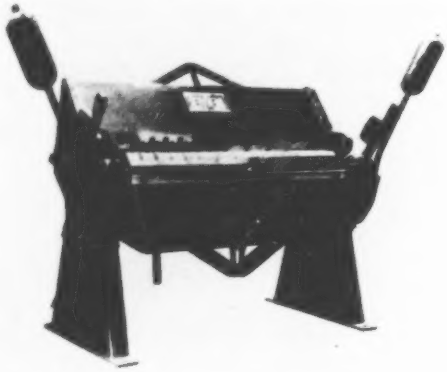
FIGURE 78



B. **Box-and-pan brake** — Has removable sections called fingers to allow extra working clearance; used for bending the fourth side of a box without distorting the other three sides

EXAMPLE:

FIGURE 79

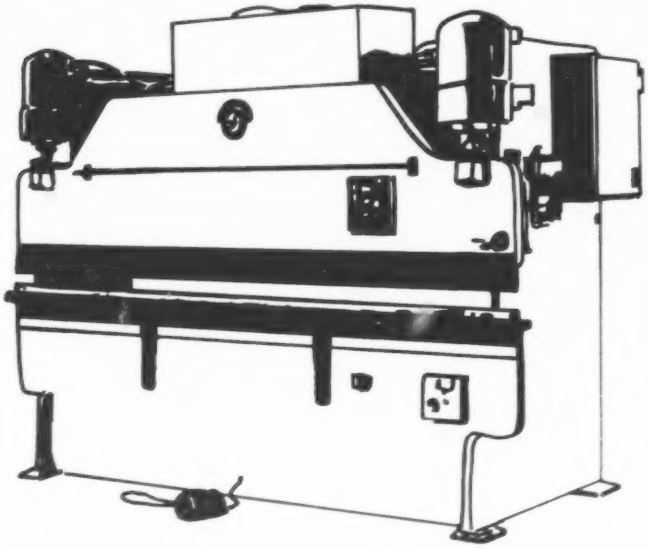


INFORMATION SHEET

C. Press brake — Has special dies that it presses metal into; it is more of a production tool and available in sizes from 4 feet to 35 feet long

EXAMPLE:

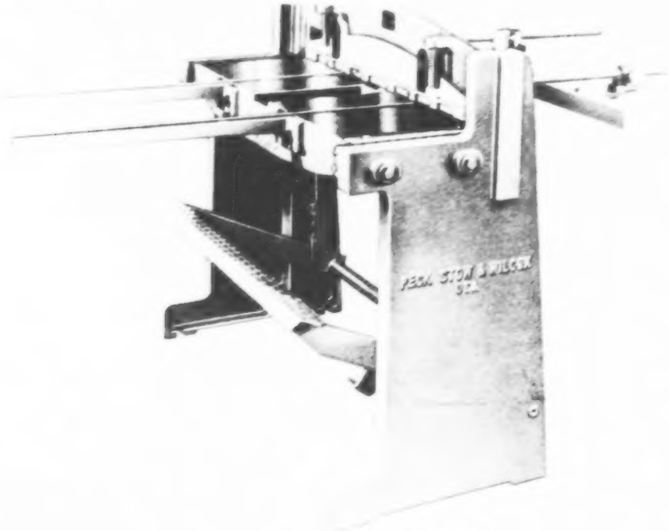
FIGURE 80



D. Square shear — Has a manually operated foot pedal for straight line cuts and is available in lengths from 3 feet to 10 feet

EXAMPLE:

FIGURE 81

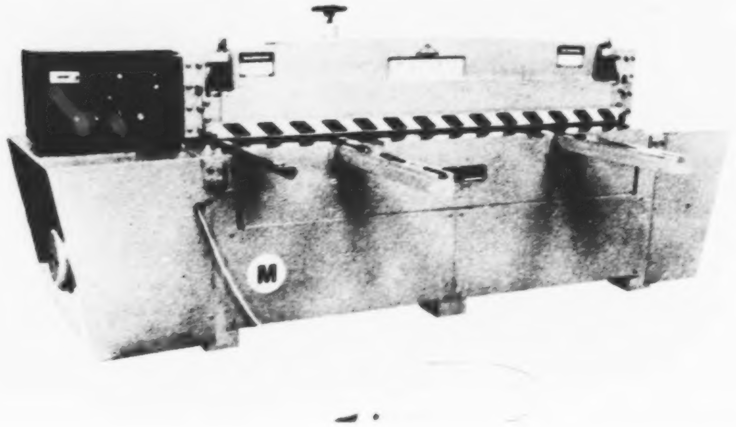


INFORMATION SHEET

E. Power shear — Similar to square shear except it is motor operated and run by hydraulic or mechanical arrangement

EXAMPLE:

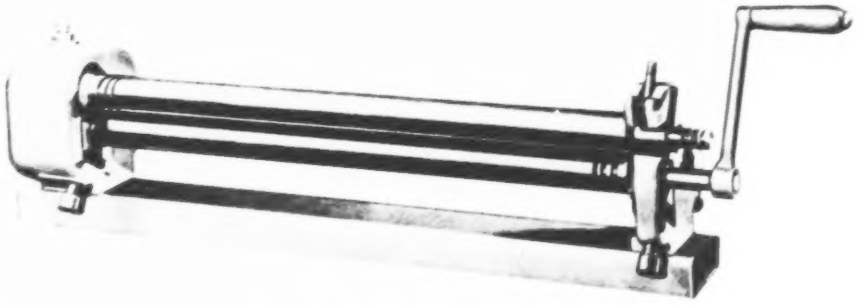
FIGURE 82



F. Slip roll — Indispensable for making pipe and small round projects

EXAMPLE:

FIGURE 83

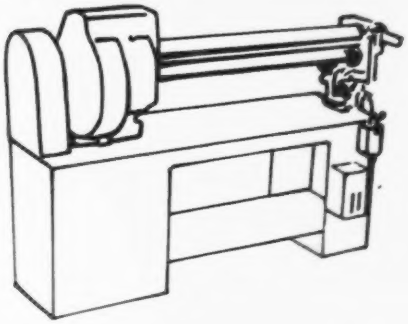


INFORMATION SHEET

G. Power roll — For production of cylindrical objects from heavier materials

EXAMPLE:

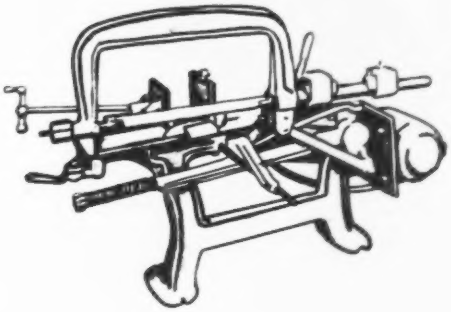
FIGURE 84



H. Power hacksaw — Used to speed up production of cutting light steel pipe and angles

EXAMPLE:

FIGURE 85

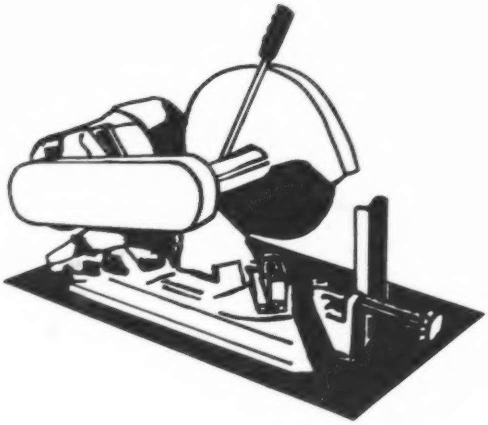


INFORMATION SHEET

I. Cut-off saw — Used to cut heavier steel at different angles or in straight cuts

EXAMPLE:

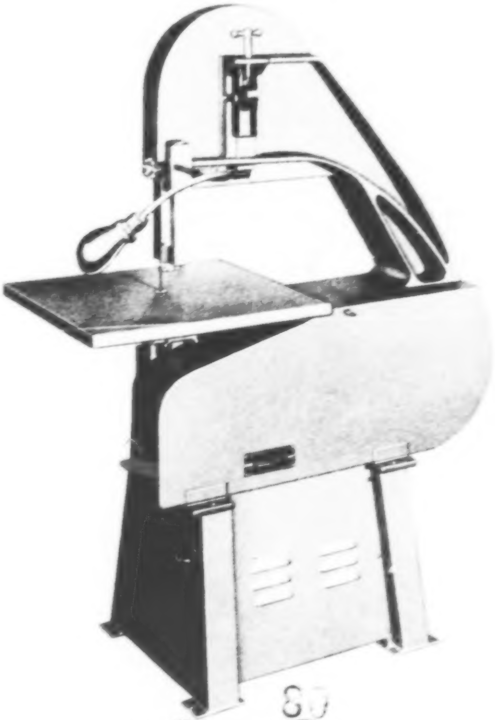
FIGURE 86



J. Band saw — Has a continuous-cutting blade for cutting mild steel

EXAMPLE:

FIGURE 87

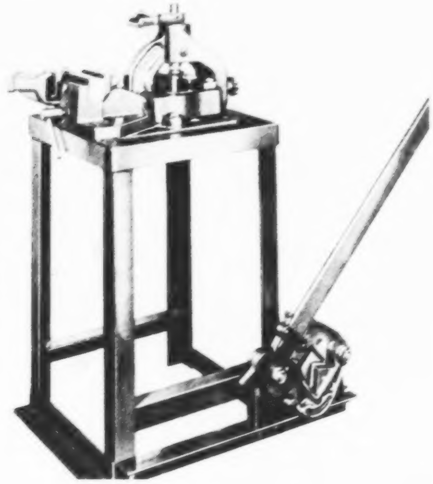


INFORMATION SHEET

K. Angle iron shear, notcher, and bender — Used to cut, notch, and bend angle iron, and is a must when angle iron is being worked with

EXAMPLE:

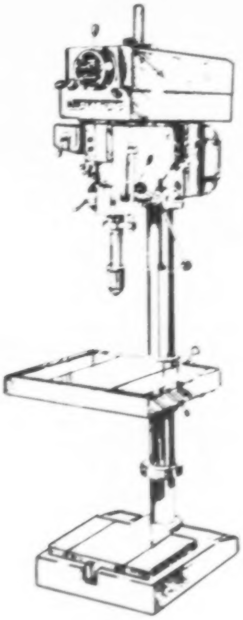
FIGURE 88



L. Drill press — Used for drilling holes in several pieces of light metal at one time or drilling holes in single pieces of heavier metal

EXAMPLE:

FIGURE 89

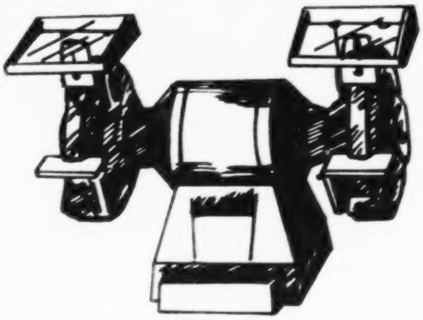


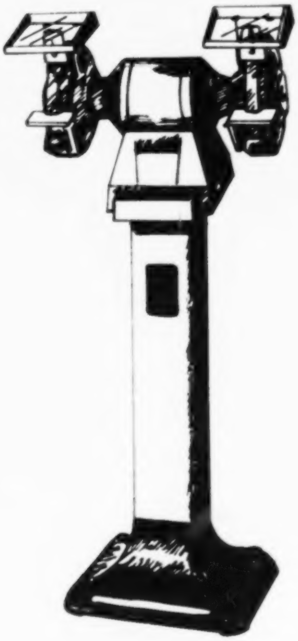
INFORMATION SHEET

M. Bench or floor grinder — Used for grinding, sharpening, or cleaning up welded materials

EXAMPLES:

FIGURE 90

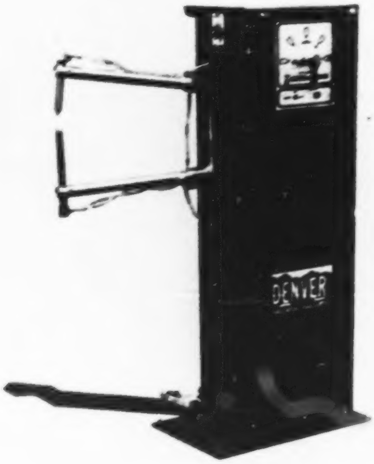




N. Resistance spot welder — A special machine for sheet metal attachment because it bonds two pieces of metal together without the use of any added materials

EXAMPLE:

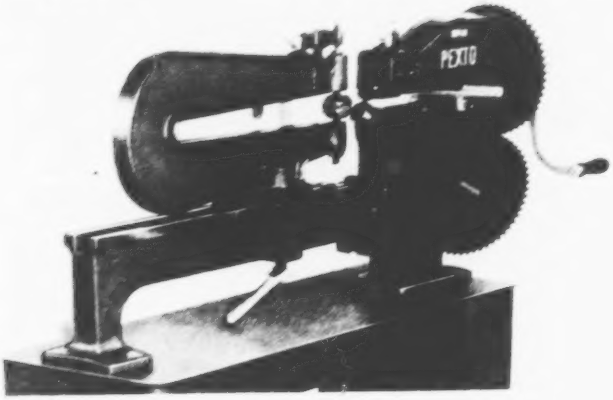
FIGURE 91



O. Rotary circle shear — Used for cutting sheet metal discs for bottoms and tops of cans; can also be used for slitting sheets of metal

EXAMPLE:

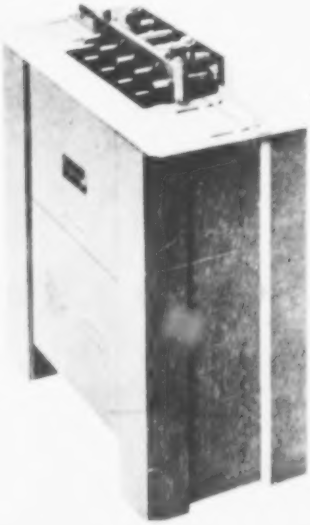
FIGURE 92



P. Standard Pittsburgh machine — Used to make Pittburgh locks that have to be closed by hand with a setting hammer or electric or air Pittsburgh hammer

EXAMPLE:

FIGURE 93



INFORMATION SHEET

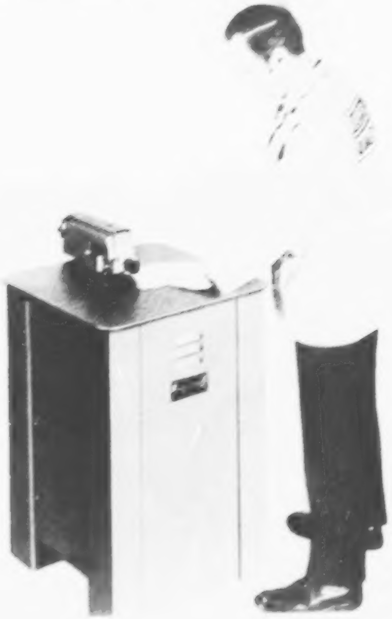
Q. Snap-lock machine for rectangular duct — Looks like a standard Pittsburgh machine, but has different rolls for making joints that can be snapped together by hand

R. Snap-lock machine for round pipe — A Pittsburgh machine which can be converted by changing rolls to make a snap-lock joint for round pipe

S. Power flanger — Designed for putting short flanges on heavier curved or circular material, and has an optional flanging attachment that will assemble to the top of most Pittsburgh machines

EXAMPLE:

FIGURE 94

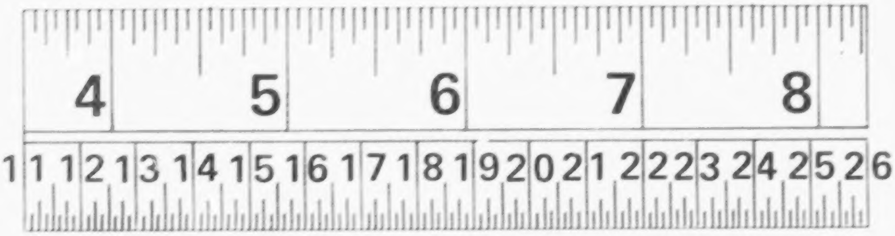


TOOLS
UNIT II

ASSIGNMENT SHEET #1 — USE A CIRCUMFERENCE RULE TO PERFORM MEASURING ACTIVITIES

NAME ______________________________ SCORE ____________

The segment of a circumference rule shown below is to scale; use this plus full-length circumference rule to answer the following questoins and perform the indicated activities.



A. What is the circumference of a pipe with a 7" diameter?

____

B. What is the diameter of a pipe with a 19" circumference? (Answer to the nearest 1/16".)

____

C. What is the total length to the nearest 1/4" of the segment illustrated above?

____

D. What is the width to the nearest 1/4" of the segment illustrated above?

____

E. Complete the following list of ways a circumference rule can be used.

1. As a straightedge for layout work
2. To make irregular curves in layout work
3. ______________________________
4. ______________________________

ASSIGNMENT SHEET #1

5. ____

6. ____

F. Turn to the appropriate table on the back of the circumference rule and determine the diameter and height required for a 20-gallon trash can.

Diameter: ____________, Height: ____________

(NOTE: The tables on the back of the circumference rule are not frequently used, but every now and then they come in handy and it's good to know where to find quick references.)

TOOLS
UNIT II

ASSIGNMENT SHEET #2 — IDENTIFY SHEET METAL HAND TOOLS

NAME ____________________ SCORE __________

Your instructor has tagged and numbered 20 hand tools that are frequently used in sheet metal work. Look the tools over carefully and write the name of each tool in the proper blank below.

#1 ____________________

#2 ____________________

#3 ____________________

#4 ____________________

#5 ____________________

#6 ____________________

#7 ____________________

#8 ____________________

#9 ____________________

#10 ____________________

#11 ____________________

#12 ____________________

#13 ____________________

#14 ____________________

#15 ____________________

#16 ____________________

#17 ____________________

#18 ____________________

#19 ____________________

#20 ____________________

SHEET METAL TOOLS
UNIT II

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1

A. 22"
B. 6 1/16"
C. 4 3/4"
D. 1 1/4"
E. The following answers may be in any order.
    3. To find the circumference of a circle when only the diameter is known
    4. To find the diameter of a circle when only the circumference is known
    5. To measure length to 1/16"
    6. To measure standard seam allowances
F. Diameter : 17 1/4", Height: 19 3/4"

Assignment Sheet #2 — Evaluated to the satisfaction of the instructor.

SHEET METAL TOOLS
UNIT II

TEST

NAME ____________________________________ SCORE ________________

1. Match to their correct definitions terms associated with hand tools. Write the correct numbers in the blanks.

_____a. Thickness of sheet metal or wire; also a device to measure that thickness

_____b. Irregular edges on sheet metal that turn up and roll into a fishhook shape resulting from improper use of cutting snips

_____c. To scratch on a piece of metal with another piece of metal to make a line or a pattern; also a device for scratching on metal

_____d. Unusable metal remaining after a pattern has been cut

_____e. The use of hand snips with such a degree of skill that cut edges are left smooth and clean and free of burrs or fishhooks

1. Waste
2. Cutting technique
3. Gauge
4. Scribe
5. Burrs or fishhooks

2. Match types of measuring tools to their uses. Write the correct numbers in the blanks.

_____a. Used for measuring linear distances; graduated to 1/16 inch; usually 24 inches, 36 inches, or 48 inches long

_____b. Used fo find the circumference of a circle when the diameter is known or the diameter of a circle when the circumference is known; also used as a straightedge and for other activities in layout work

_____c. Take up little space, are handy to carry and easy to use; available in lengths from 6 feet to 25 feet and graduated to 1/16 inch

_____d. Commonly used in sheet metal work; usually 6 feet long and graduated to 1/16 inch

1. Circumference rules
2. Retractable steel tape rules
3. Steel rules
4. Inside-reading folding rules

TEST

3. Match types of dividers to their uses. Write the correct numbers in the blanks.

______a. Used to construct large circles and arcs

______b. Used to construct small circles and arcs and to transfer dimensions

1. Trammel points
2. Wing dividers

4. Match types of squares to their uses. Write the correct numbers in the blanks.

______a. Used for accuracy in layout work; blades are available in 6-inch, 8-inch, 10-inch, and 12-inch lengths

______b. Used for layout accuracy with 45° and 90° angles

______c. Used in layout work for accuracy because all layout must start from a square corner

1. Framing squares
2. Try squares
3. Combination squares

5. Distinguish between a bevel protractor and a steel swinging-blade protractor by placing an "X" beside the dcsription of a bevel protractor.

______a. Used to find or construct angles of different degrees

______b. Used to find or construct angles of different degrees; lighter and easy to carry in a tool box

6. Match types of sheet metal snips to their uses. Write the correct numbers in the blanks.

______a. Cuts to the left around curves and 90° corners

______b. Cuts to the right around curves and 90° corners

______c. Cuts straight lines or curves; one style has very short blades for special cutting needs

______d. Heavy duty snips used for all general cuts and thicker metals

______e. For cutting inside circles and metal close to an obstacle

______f. Best for cutting straight lines

______g. Will cut curves by letting the metal slide over the top blade with ease, and will also cut straight

______h. Specifically designed to cut ⅛-inch wide slit in preformed metal duct

1. Straight cut
2. Bulldog
3. Straight blade
4. Combination blade
5. Right cut
6. Circular
7. Left cut
8. Double cut

TEST

7. Match types of punches to their uses. Write the correct numbers in the blanks.

_____a. Used to make small dents or establishing points for trammel points and wing dividers; point is ground to approximately 30°

_____b. Used for marking the location to be drilled; point is ground to approximately 90°

_____c. Used to punch small holes in light gauge metal; punches and dies range in size from 1/16-inch to 9/32-inch, and are easily changed

_____d. Used on heavier gauge material; punches and dies range from 1/16-inch to 1/2-inch, and are easily changed

1. Iron hand punch
2. Center punch
3. Tinner's hand punch
4. Prick punch

8. Match types of hammers to their uses. Write the correct numbers in the blanks.

_____a. Has a slightly curved, square face and beveled edges to prevent marking metal as rivets are set

_____b. Has a square, flat face and flat sides for closing up a Pittsburgh lock

_____c. General purpose hammer with a curved face and round head

_____d. Not considered a sheet metal tool, but is found and used in almost all sheet metal shops

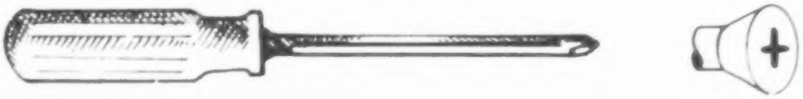
_____e. Used mostly as a finish tool, in cornice work, and in stainless steel work

_____f. Made of good hickory or rawhide and used where a metal hammer would dent or damage material

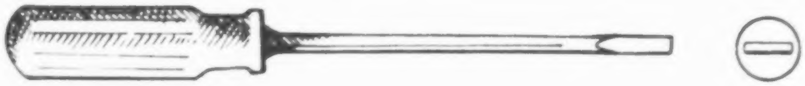
1. Ball peen hammer
2. Mallet
3. Setting hammer
4. Body or raising hammer
5. Nail hammer
6. Riveting hammer

9. Distinguish between a standard screwdrier and a Phillips screwdriver by placing an "X" beside the illustration of a standard screwdriver.

_____a.



_____b.



TEST

10. Match types of pliers to their uses. Write the correct numbers in the blanks.

_____a. Long nose and handle for deeper reach into work area

_____b. For holding an object that is difficult to hold with one's hands; should *not* be used as a wrench for removing nuts

_____c. Jaws are positioned and locked into place by engaging tongue in proper groove; a series of channels give wide range of jaw openings; jaws should not slip even under heavy pressure

_____d. Pliers adjust easily to lock at any size with desired amount of pressure; release lever opens jaws; can also be used as nonlocking pliers

1. Combination pliers
2. Adjustable pliers
3. Locking pliers
4. Long nose pliers

11. Match types of metal marking devices to their uses. Write the correct numbers in the blanks.

_____a. Used to scribe lines on metal in sheet metal layout; used with a guide

_____b. Used to scribe lines on metal using the edge of the metal as straightedge, but can be used in many ways depending on type

1. Scratch gauge
2. Scratch awl

12. Match types of metal gauges to their uses. Write the correct numbers in the blanks.

_____a. Used for measuring uncoated sheet, plate iron and steel; based on weights in ounces per square foot

_____b. Used for measuring the thickness of sheets and wire made of nonferrous metals such as copper, brass, and aluminum

1. U.S. standard gauge
2. American standard wire gauge

13. Match types of miscellaneous hand tools to their uses. Write the correct numbers in the blanks.

_____a. Makes bends on light gauge metal which is inconvenient to bend on a brake

_____b. Used to cut clips for joining round pipe to a flat or round piece of metal

1. Stake plate
2. Clip punch

TEST

______c. Used for cutting rivets, bolts, and metal; point is ground to 70°

______d. Used to hook into drive cleats in duct work to pull the duct together

______e. Used to buck the head of a rivet as it is pulled together

______f. An efficient tool for fastening seams in duct work; an "ear" is cut and bent out to be hammered tight with a hammer

______g. Used for notching duct work corners for "S" and drive clips

______h. Used to reduce the size of the end of a pipe; permits one end of pipe to fit inside another piece that is the same size

______i. Steel plate with various size holes designed to hold the tapered end of stakes firmly so the stakes can be used for forming metal

______j. Designed to fit various size nuts within its capacity; comes in various sizes

______k. Tool that is struck with a hammer to form hammer-lock pipe seams by hand; also used in completing Pittsburgh seams

______l. Used to cut various types of metal

______m. Shaping tools used with hand tools to complete numerous sheet metal operations such as tube forming, taper forming, flanging, side and circular seaming, box and pail seaming, riveting, and grooving

______n. Made with a deep hole used to pull tinner's rivets through metal, and a cup shaped hole to set the rivets; a hole in the side is for releasing burrs

______o. Rivet-setting tool designed for rivets to be inserted and set from one side in aluminum, steel, and copper; rivets range in size from 1/8-inch to 1/4-inch

______p. Used to remove burrs, to square the end of band iron, and to straighten uneven edges

3. Flat cold chisel
4. Rivet set
5. Hand groover
6. Hand seamer
7. Pipe crimper
8. Stakes
9. Multiple-use dolly bar
10. File
11. Dovetailer
12. Adjustable wrench
13. Pop-rivet gun
14. Hand notcher
15. Duct stretcher
16. Hacksaw

TEST

14. Match terms associated with machine tools to their defintions. Write the correct numbers in the blanks.

______a. Small, hand-operated tools generally anchored to a bench and used for one or more operations on cylindrical projects

______b. Small, electrically or air-operated tools that can be comfortably moved from job to job

______c. Medium to large tools that are usually secured in a permanent position for forming and working with sheet metal

______d. Machines for making straight line bends to specified angles for rectangular components

______e. Machines for making cylindrical components

______f. The amount of material required to fabricate a given component not including seam or joint allowance

______g. Cutting out by hand or on a square shear all the material required to complete a pattern

1. Rolls
2. Blocking out
3. Stretchout
4. Prick punch
5. Brakes
6. Portable power tools
7. Manual and power-operated floor tools

15. Match types of bench tools to their uses. Write the correct numbers in the blanks.

______a. For folding, bending, hemming, setting down, and making drive clips

______b. For double-seaming flat bottoms on straight or flared cylindrical articles

______c. For turning edges on circular discs such as bucket bottoms and for turning edges for double-seaming cylindrically shaped projects

______d. For various bending operations with single and ogee rolls

______e. For making rounded edges for wiring operations on cylinders, and for double-seaming

______f. A specialized machine for grooving longitudinal seams in cylinders by grooving and flattening in one operation of the carriage

1. Burring machine
2. Grooving machine
3. Crimping and beading machine
4. Adjustable-bar folder
5. Beading machine
6. Double seam machine
7. Elbow-edging machine
8. Turning machine

TEST

_____g. For crimping and beading the end of a cylinder

_____h. For setting down seams on containers of various shapes

_____i. For turning the edges of elbow gores so the gores can be assembled as a complete elbow with tight or adjustable joints

_____j. Has numerous interchangeable rolls to facilitate several different operations simply by changing to the desired set of rolls

_____k. Turns perfect flanges on curved metal edges

_____l. Throatless shear which will cut straight or curved lines without distortion in heavy to light metals

_____m. A tool used to turn drives on preassembled duct

_____n. For clamping stock to be worked on; the swivel base type is the most common

9. Combination rotary machine
10. Easy edger
11. Bench vise
12. Setting-down machine
13. Cleat bender
14. Multi-purpose bench lever shear

16. Match types of portable power tools to their uses. Write the correct numbers in the blanks.

_____a. A portable electric keyhole saw with various types and sizes of blades for cutting wood, metal, plastics, and heavier steel

_____b. A general purpose saw used in the construction trades for cutting wood, metal, and plastics

_____c. Generally used with attachments for cleaning joints after a welding process

_____d. Generally used for light drilling jobs; comes in various types such as variable-speed, reversible, $^1/_4$-inch, $^3/_8$-inch, and $^1/_2$-inch capacities

_____e. Generally used for drilling heavy or thick materials; comes in various types such as, variable-speed, reversible, $^1/_2$-inch, $^3/_4$-inch, 1-inch, and 1 $^1/_4$-inch capacities

1. Angle grinder
2. Heavy-duty hand drill
3. Nibbler
4. Reciprocating saw
5. Circular saw
6. Hand drill
7. Power double cuts
8. Unishear
9. Hammer drill

TEST

______f. A hand-held metal-cutting shear for heavy metals

______g. Separates metal by punching 1/8-inch pieces out of the metal with a rapid punching action to speed up pattern cutting with light to heavy gauge metals

______h. For cutting a cylinder into two or more pieces with minimum waste and time

______i. A heavy-duty drill with a percussion bit for drilling through masonry, brick, and tile

17. Match types of manual and power-operated floor tools to their uses. Write the correct numbers in the blanks.

______a. A machine used for bending or forming flat metal into various shapes; may be in 4-foot, 5-foot, 8-foot, 10-foot, or longer lengths

______b. Has removable sections called fingers to allow extra working clearance; used for bending the fourth side of a box without distorting the other three sides

______c. Has special dies that it presses metal into; it is more of a production tool and available in sizes from 4 feet to 35 feet long

______d. Has a manually operated foot pedal for straight line cuts and is available in lengths from 3 feet to 10 feet

______e. Similar to square shear except it is motor operated and run by hydraulic or mechanical arrangement

______f. Indispensable for making pipe and small round projects

______g. For production of cylindrical objects from heavier materials

______h. Used to speed up production of cutting light steel pipe and angles

______i. Used to cut heavier steel at different angles or in straight cuts

1. Square shear
2. Press brake
3. Slip roll
4. Power shear
5. Hand brake
6. Band saw
7. Box-and-pan brake
8. Cut-off saw
9. Angle iron shear, notcher, and bender
10. Bench or floor grinder
11. Power roll
12. Power hacksaw
13. Resistance spot welder
14. Snap-lock machine for round pipe
15. Drill press

TEST

______j. Has a continuous-cutting blade for cutting mild steel

______k. Used to cut, notch, and bend angle iron, and is a must when angle iron is being worked with

______l. Used for drilling holes in several pieces of light metal at one time or drilling single holes in heavier metals

______m. Used for grinding, sharpening, or cleaning up welded materials

______n. A special machine for sheet metal attachment because it bonds two pieces of metal together without the use of any added materials

______o. Used for cutting sheet metal discs for bottoms and tops of cans; can also be used for slitting sheets of metal

______p. Used to make Pittsburgh locks that have to be closed by hand with a setting hammer or electric or air Pittsburgh hammer

______q. Looks like a standard Pittsburgh machine, but has different rolls for making joints that can be snapped together by hand

______r. A Pittsburgh machine which can be converted by changing rolls to make a snap-lock joint for round pipe

______s. Designed for putting short flanges on heavier curved or circular material, and has an optional flanging attachment that will assemble to the top of most Pittsburgh machines

16. Power flanger
17. Snap-lock machine for rectangular duct
18. Rotary circle shear
19. Standard Pittsburgh machine

(NOTE: Test items 18 and 19 are the assignment sheets. They are an important part of this test. If they have not been completed, check with your instructor.)

18. Use a circumference rule to perform measuring activities.

19. Identify sheet metal hand tools.

SHEET METAL TOOLS
UNIT II

ANSWERS TO TEST

1. a. 3   c. 4   e. 2
   b. 5   d. 1

2. a. 3   c. 2
   b. 1   d. 4

3. a. 1
   b. 2

4. a. 2   c. 1
   b. 3

5. a

6. a. 7   c. 1   e. 6   g. 4
   b. 5   d. 2   f. 3   h. 8

7. a. 4   c. 3
   b. 2   d. 1

8. a. 6   c. 1   e. 4
   b. 3   d. 5   f. 2

9. b

10. a. 4   c. 2
    b. 1   d. 3

11. a. 2
    b. 1

12. a. 1
    b. 2

ANSWERS TO TEST

13.
a. 6
b. 11
c. 3
d. 15
e. 9
f. 2
g. 14
h. 7
i. 1
j. 12
k. 5
l. 16
m. 8
n. 4
o. 13
p. 10

14.
a. 4
b. 6
c. 7
d. 5
e. 1
f. 3
g. 2

15.
a. 4
b. 6
c. 1
d. 5
e. 8
f. 2
g. 3
h. 12
i. 7
j. 9
k. 10
l. 14
m. 13
n. 11

16.
a. 4
b. 5
c. 1
d. 6
e. 2
f. 8
g. 3
h. 7
i. 9

17.
a. 5
b. 7
c. 2
d. 1
e. 4
f. 3
g. 11
h. 12
i. 8
j. 6
k. 9
l. 15
m. 10
n. 13
o. 18
p. 19
q. 17
r. 14
s. 16

18. Evaluated to the satisfaction of the instructor.

19. Evaluated to the satisfaction of the instructor.

SHEET METAL LAYOUT
UNIT III

UNIT OBJECTIVE

After completing this unit, the student should be able to identify basic geometric figures and should be able to draw basic geometric constructions. The student will show this ability by completing the assignment sheet, job sheets, and unit test with a minimum score of 80 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match terms associated to sheet metal layout to their definitions.
2. Match types of basic geometric figures to their descriptions.
3. Bisect a straight line.
4. Bisect an angle.
5. Label the elements related to drawing circles.
6. Erect a perpendicular at the end of a straight line.
7. Erect a perpendicular from a point to a line.
8. Pass an arc of a given radius through two given points.
9. Pass an arc through three given points.
10. Inscribe a circle within a triangle.
11. Divide a line into equal parts.
12. Divide a circle into six equal parts.
13. Divide a circle into twelve equal parts.
14. Construct parallel lines.
15. Construct an equilateral triangle with the altitude known.
16. Find the center of a circle.
17. Draw an ellipse.

OBJECTIVE SHEET

18. Create approximately 30° and 60° angles with a compass.
19. Practice drawing basic geometric constructions.
20. Demonstrate the ability to
    a. Lay out to specifications a metal box.
    b. Lay out a rectangular duct.
    c. Lay out a circle on sheet metal.

SHEET METAL LAYOUT
UNIT III

SUGGESTED ACTIVITIES

I. Unit contents

  A. Objective sheet

  B. Suggested activities

  C. Information sheet

  D. Assignment Sheet #1 — Practice Drawing Basic Geometric Constructions

  E. Answers to assignment sheet

  F. Job sheets

    1. Job Sheet #1 — Lay Out to Specifications a Metal Box

    2. Job Sheet #2 — Lay Out a Rectangular Duct

    3. Job Sheet #3 — Lay Out a Circle on Sheet Metal

  G. Test

  H. Answers to test

II. Instructor's guide

  A. Review unit and plan presentation.

  B. Obtain tools and materials necessary to accomplish procedures in assignment and job sheets.

  C. Introduce unit to students.

  D. Provide students with objective sheet.

  E. Discuss unit and specific objectives.

  F. Provide students with information, assignment and job sheets.

  G. Discuss information, assignment and job sheets.

    1. Use Information Sheet, Section I, to discuss terms and definitions associated with sheet metal layout.

      - Have students review terms.
      - Show examples of as many terms as possible.
      - Explain to students the importance of knowing these terms and definitions and how knowing them will help the students to better understand this unit.

    2. Use Information Sheet, Section II, to discuss basic geometric figures and their descriptions.

SUGGESTED ACTIVITIES

- Make flash cards with drawings of the basic geometric figures on them. Have students identify the name of the figure and give a description of each one they can identify.
- Relate the geometric figures to the assignment sheet and the geometric constructions.

3. Use Information Sheet, Sections III through XIX, to discuss bisecting lines, erecting perpendicular lines, passing an arc through given points, dividing lines and circles, constructing parallel lines, lines for other geometric figures, center points and drawing an ellipse.

    - Have students review steps in Sections III through XIX.
    - Have students review and practice procedures in the information sheet and the assignment sheet.
    - Use chalkboard to demonstrate the objectives in the information sheet. Explain to the students how important these objectives are to basic layout activities and how important it is for the students to become familiar with the terminology and the procedures used to complete all the activites.
    - Have students complete the assignment sheet.
    - Discuss and demonstrate procedures outlined in the job sheets.
    - Evaluate the assignment sheet and repeat demonstrations for constructions that students have difficulty with.
    - Have students complete job sheets.

H. Give test.

I. Critique test and discuss in class.

J. Reteach and retest as necessary.

K. Complete appropriate section of competency profiles.

(NOTE: A master of the competency profile for this book is provided at the front of the instructor edition. You may duplicate the profile and distribute it to students as needed.)

III. Unit references

A. Hendrix, Laborn J. "Bud." *Fundamentals of Carpentry*. Stillwater, Oklahoma: State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center, and The Associated General Contractors of America, 1985.

B. Jones, Leonard and Morse, Otto. *Basic Sheet Metal Layout and Fabrication*. Stillwater, Oklahoma: Mid-America Vocational Curriculum Consortium, Inc., 1983.

SHEET METAL LAYOUT
UNIT III

INFORMATION SHEET

I. Terms and definitions associated with sheet metal layout

A. **Geometric figure** — Shape formed by straight or curved lines

B. **Perimeter** — Outer limits or boundary

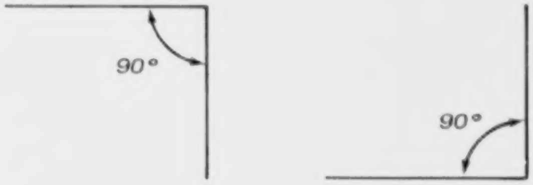
C. **Lineal** — Relating to, consisting of, or resembling a straight line

D. **Bisect** — Divide into two equal parts

E. **Right angle** — Angle formed by two lines perpendicular to each other; 90-degree angle (Figure 1)

EXAMPLE:

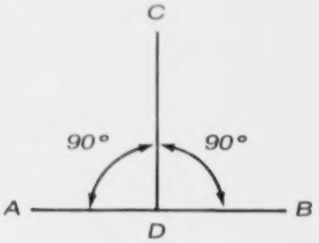
FIGURE 1



F. **Perpendicular** — Line or surface at a right angle to another line or surface

EXAMPLE: Line CD is perpendicular to line AB; see Figure 2.

FIGURE 2

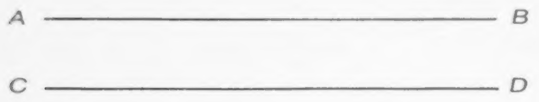


INFORMATION SHEET

G. **Parallel** — Extending in the same direction an equal distance apart and never meeting

EXAMPLE: Lines AB and CD are parallel to each other; see Figure 3.

FIGURE 3



H. **Equilateral** — A figure having all sides equal

I. **Ellipse** — The path of a point that moves so that the sum of its distance from two fixed points is constant to create a figure that falls short of a perfect circle

J. **Chord** — A straight line joining any two points on an arc, curve, or circumference

K. **Arc** — A segment of a circle

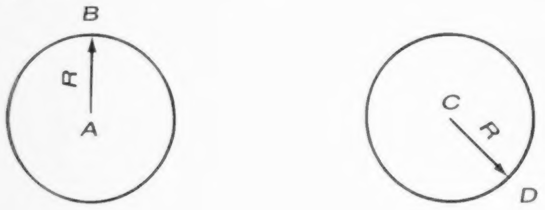
L. **Tangent** — A line or plane that touches at only one point but does not intersect a curve, an arc, or a circumference

M. **Point of tangent** — The point at which a line or a plane touches a curve, an arc, or a circumference

N. **Radius** — Distance from center of a circle to any point on edge of circle

EXAMPLE: AB and CD represent the radius; see Figure 4.

FIGURE 4

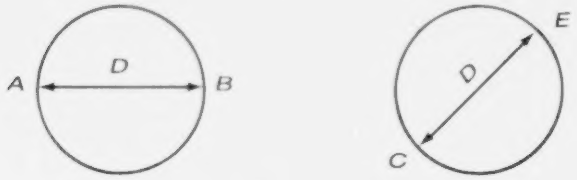


INFORMATION SHEET

O. **Diameter** — Distance between outer edges of a circle through center point

EXAMPLE: AB and CE represent the diameter; see Figure 5.

FIGURE 5



P. **Circumference** — Distance around outer edge of a circle

Q. **Pi** — Greek letter (π) representing the ratio of a circle's circumference to its diameter, which is approximately 3.1416

R. **Area** — Measure of a flat surface; expressed in square units

EXAMPLE: A 3′ – 0″ × 4′ – 0″ piece of sheet metal has an area of 12 square feet.

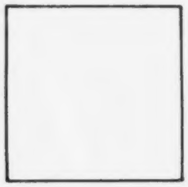
S. **Block out** — Cut out by hand or on a square shear all the material required to complete a pattern

II. Types of geometric figures (Figures 6-12)

A. Square — Figure having four sides of equal length and four right angles

EXAMPLE:

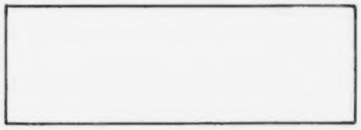
FIGURE 6



B. Rectangle — Figure with two parallel ends of equal length, two parallel sides of equal length, and four right angles

EXAMPLE:

FIGURE 7

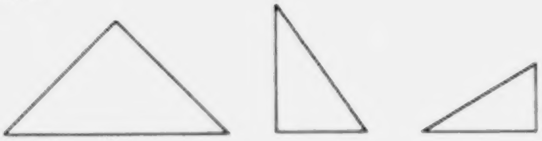


INFORMATION SHEET

C. Triangle — Figure having three sides and three angles

EXAMPLES:

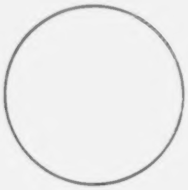
FIGURE 8



D. Circle — Flat, round figure formed by one curved line; all points of curved line are equidistant from center point

EXAMPLE:

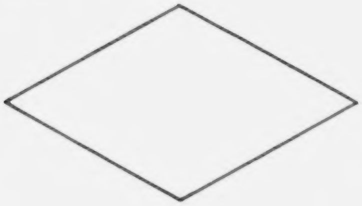
FIGURE 9



E. Rhombus — Figure having no right angles and four sides of equal length

EXAMPLE:

FIGURE 10



INFORMATION SHEET

F. Parallelogram — Figure such as a square, rectangle, or rhombus with two parallel ends of equal length and two parallel sides of equal length

EXAMPLE:

FIGURE 11

G. Trapezoid — Figure with only one pair of parallel opposite sides

EXAMPLE:

FIGURE 12

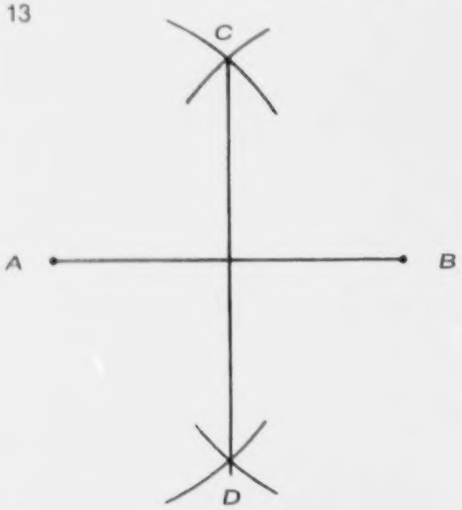
III. Steps in bisecting a straight line (Figure 13)

A. Draw line AB

B. With A and B as center, and a radius greater than one half of line AB, swing arcs above and below line AB creating points C and D

C. Connect points C and D with a straight line

FIGURE 13



INFORMATION SHEET

IV. Steps in bisecting an angle (Figure 14)

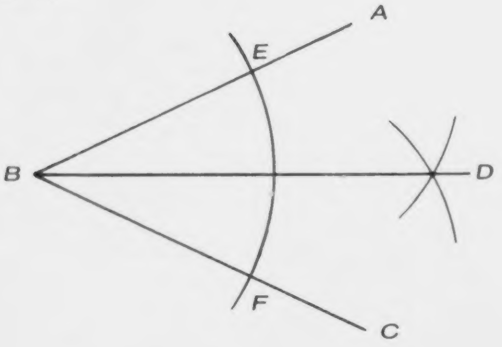
A. Construct triangle ABC

B. With B as center and a convenient radius, swing arc E through F

C. With E and F as centers and the radius greater than one-half of the distance EF, swing arcs intersecting at D

D. Draw line BD

FIGURE 14



V. Elements related to drawing circles (Figure 15)

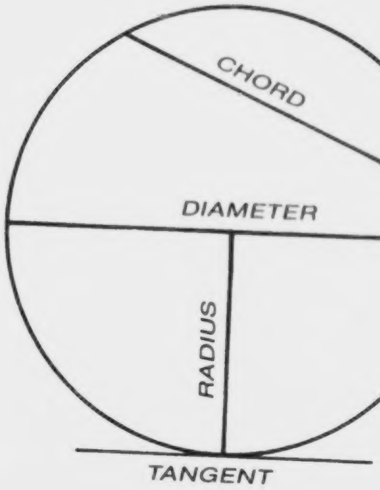
A. Diameter

B. Radius

C. Chord

D. Tangent

FIGURE 15



INFORMATION SHEET

VI. Steps in erecting a perpendicular at the end of a straight line (Figure 16)

A. Draw line AB

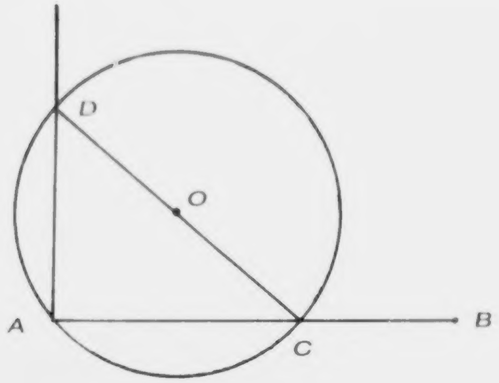
B. Select the point O outside and at a convenient distance above the line

C. With O as center and OA as a radius, draw a circle creating point C

D. Draw line from point C through point O creating point D

E. Draw line A through D

FIGURE 16



VII. Steps in erecting a perpendicular from a point to a line (See Figure 17)

A. Draw line AB

B. Place point C above line

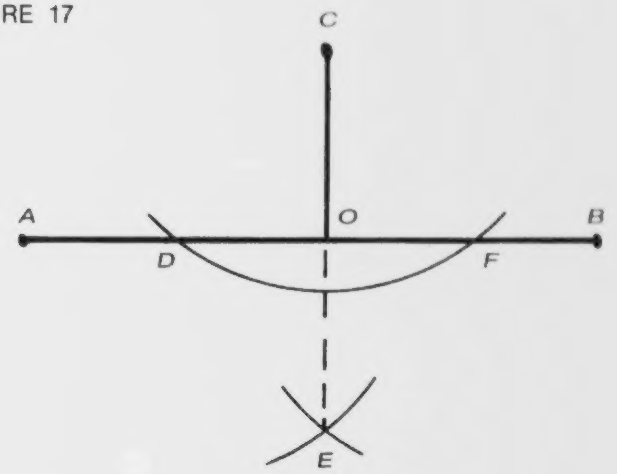
C. With C as the center, swing an arc creating points D and F

D. With D and F as centers, create point E

E. Draw line C to E

INFORMATION SHEET

FIGURE 17



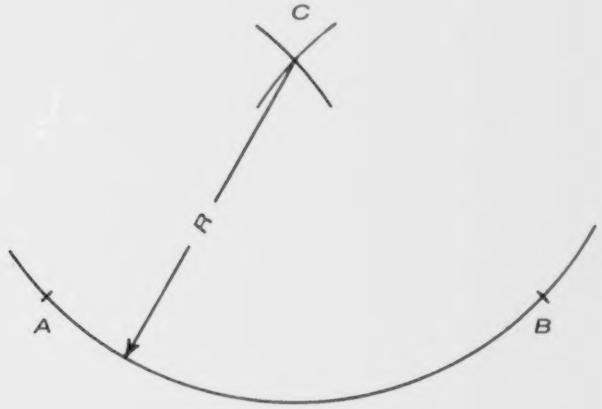
VIII. Steps in passing an arc of a given radius through two given points (Figure 18)

A. Create points A and B

B. With R as the radius, and points A and B as the centers, create point C

C. With point C as the center and R as the radius, swing arc AB

FIGURE 18



IX. Steps in passing an arc through three given points (Figure 19)

A. Create points ABC

INFORMATION SHEET

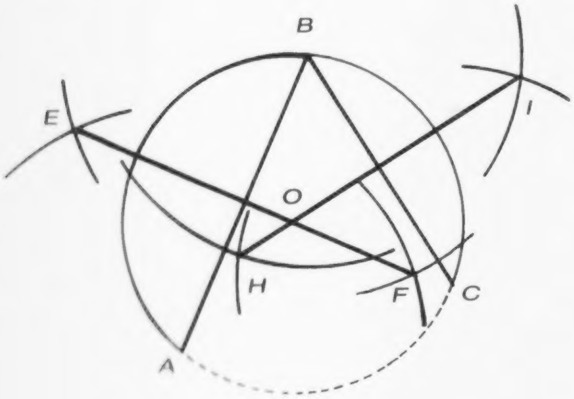
B. Connect points ABC

C. Bisect line AB

D. Bisect line BC, creating point O

E. With point O as center and OA as the radius, swing arc ABC

FIGURE 19



X. Steps in inscribing a circle within a triangle (Figure 20)

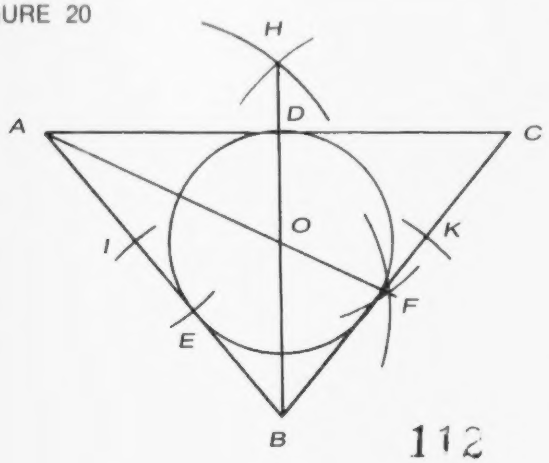
A. Construct triangle ABC

B. Bisect angle CAB

C. Bisect angle ABC, creating point O

D. O is the center of the circle inscribed in the triangle

FIGURE 20



INFORMATION SHEET

XI. Steps in dividing a line into equal parts (Figure 21)

A. Draw line AB

B. Draw line AC at convenient degree and distance

C. With AD as radius, step off desired number of segments, indicated by D, E, F, G, H

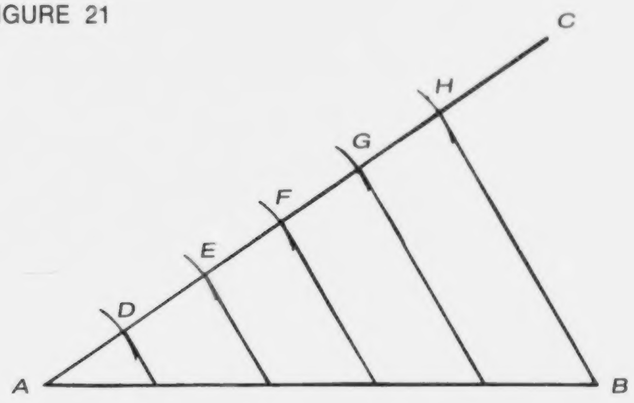
(NOTE: In this case the line will be divided into five equal parts.)

D. Draw line HB

(NOTE: If four equal parts were desired, a line GB would be drawn, and so forth.)

E. Draw lines parallel to HB through points G, F, E, and D; this divides line AB into equal parts

FIGURE 21



XII. Steps in dividing a circle into six equal parts (See Figure 22)

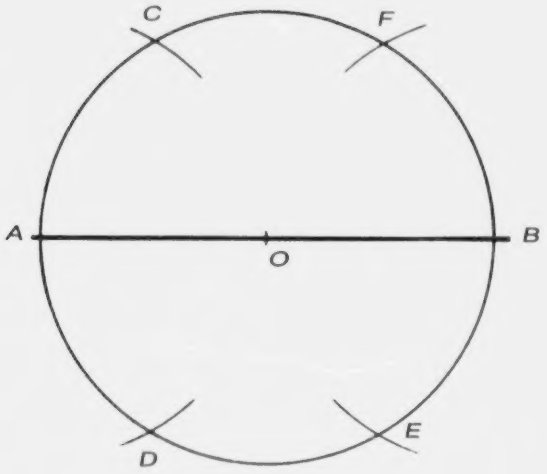
A. Construct a circle with AB as the diameter and O as the center

B. With A as a center and AO as the radius, create points C and D

C. With B as the center and AO as the radius, create points E and F; this divides a circle into six equal parts

INFORMATION SHEET

FIGURE 22



XIII. Steps in dividing a circle into twelve equal parts (Figure 23)

A. Construct a circle with a given diameter AB, with O as center

B. Draw line CD through O at 90° to line AB

C. With OA as radius and A as center, create points K and N

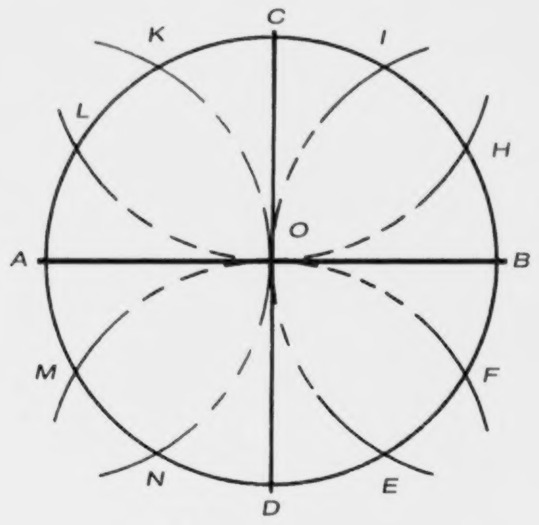
D. With D as center, create points M and F

E. With B as center, create points E and I

F. With C as center, create points L and H, this divides a circle into twelve equal parts

INFORMATION SHEET

FIGURE 23



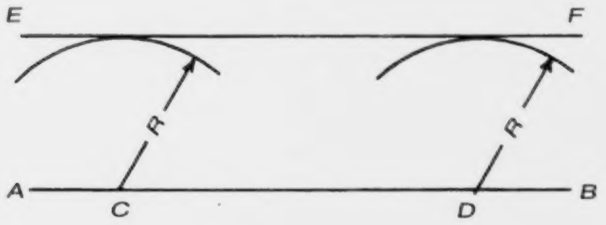
XIV. Steps in constructing parallel lines (Figures 24)

A. Draw line AB

B. With R as the radius, swing arcs from any two points on line AB

C. Draw line EF tangent to arcs to complete parallel line

FIGURE 24



XV. Steps in constructing an equilateral triangle with the altitude known (Figure 25)

A. Draw line AB to given altitude

B. Draw line CD perpendicular to AB

C. Draw line EF perpendicular to AB

D. With A as the center, and the radius less than AB, construct a semicircle HI

INFORMATION SHEET

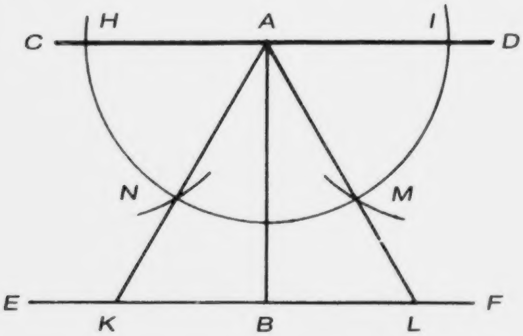
E. With H as the center, and AH as the radius, create point N

F. With I as the center, and AH as the radius, create point M

G. Draw line from point A through point N and create point K

H. Draw line from point A through point M and create point L

FIGURE 25



XVI. Steps in finding the center of a circle (Figure 26)

A. Circle is given and drawn

B. Draw chord AB

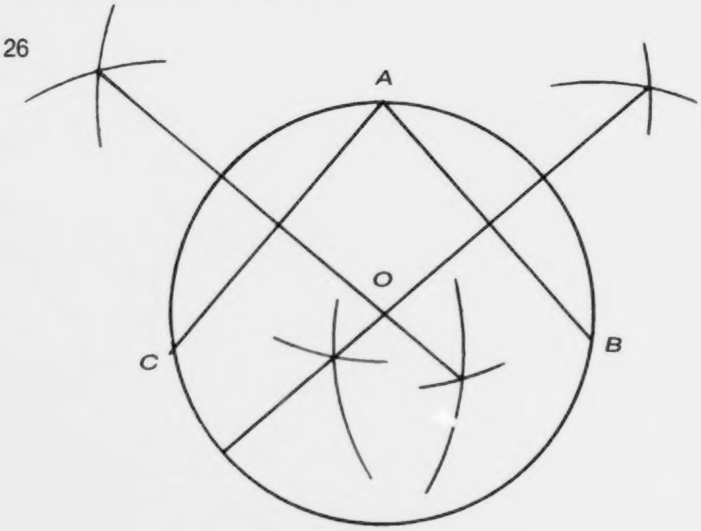
C. Bisect chord AB

D. Draw chord AC

E. Bisect chord AC

F. The intersection of the bisectors, O, is the center of the circle

FIGURE 26



XVII. Steps in drawing an ellipse (Figure 27)

A. Draw major axis AB

B. Draw minor axis CD

C. Draw line CB

D. With O as center, swing arc CG

E. With B as center, swing arc OE

F. With EG as radius and A as center, swing arc FH creating point I

G. With I as center and EG as radius, swing arc KAL

H. With B as center and EG as radius, swing arc MN creating point P

I. With P as center and EG as radius, swing arc RBS

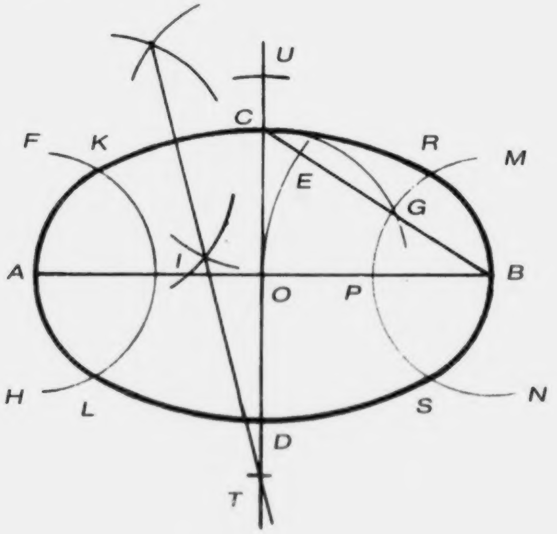
J. Bisect distance KC and create point T

K. With T as center, swing arc KCR

L. Transfer distance of TC to DU

M. With U as center, swing arc LDS

FIGURE 27



INFORMATION SHEET

XVIII. Steps in creating approximate 30° and 60° angles with a compass (Figure 28)

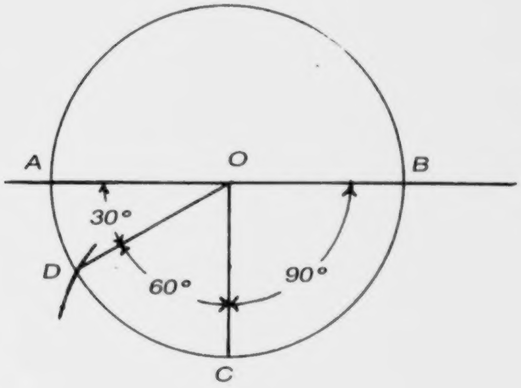
A. With O as center and OA as a radius, draw a circle

B. Draw a line perpendicular to AB at O and make point C

C. With C as a center, and OA as a radius, swing an arc to make point D

D. Connect O with D; this gives a 30° and 60° angle

FIGURE 28

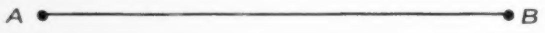


SHEET METAL LAYOUT
UNIT III

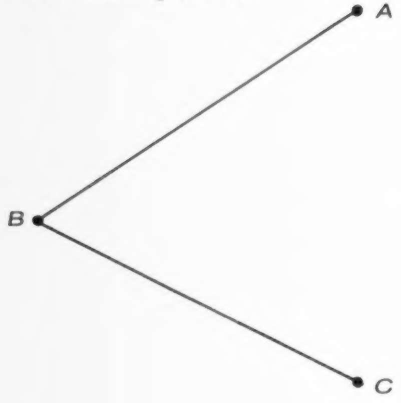
ASSIGNMENT SHEET #1 — PRACTICE DRAWING BASIC GEOMETRIC CONSTRUCTIONS

NAME ______________________________ SCORE ______________

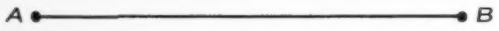
A. Bisect line AB.



B. Bisect the angle ABC.

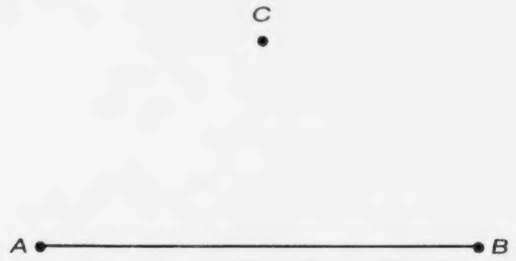


C. Erect a perpendicular above the line AB at point B.

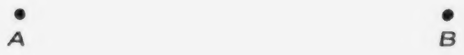


ASSIGNMENT SHEET #1

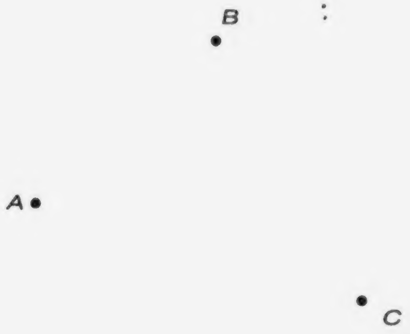
D. Erect a perpendicular from point C to line AB.



E. Pass an arc with a 2″ radius through points A and B.

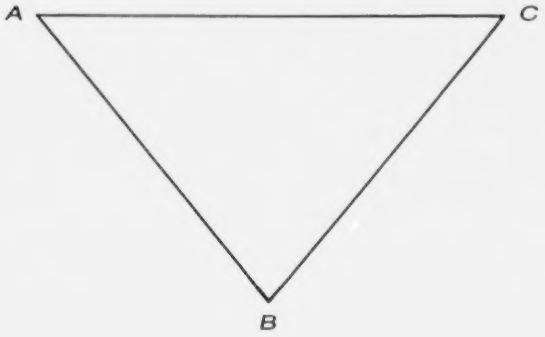


F. Pass an arc through the three points A, B and C.

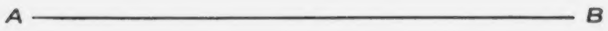


ASSIGNMENT SHEET #1

G. Inscribe a circle within the triangle ABC.

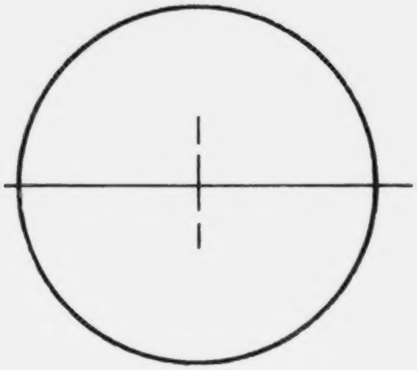


H. Divide the line AB into seven equal parts.

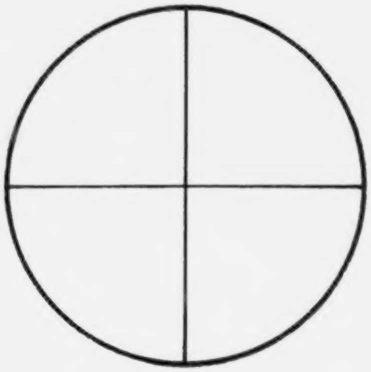


ASSIGNMENT SHEET #1

I. Divide the given circle into six equal parts.

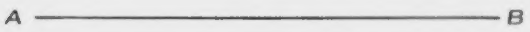


J. Divide the given circle into twelve equal parts.

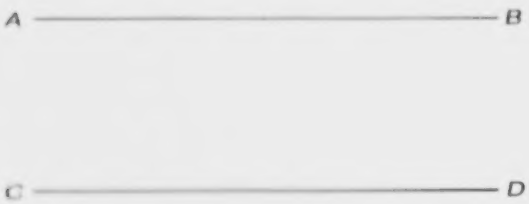


ASSIGNMENT SHEET #1

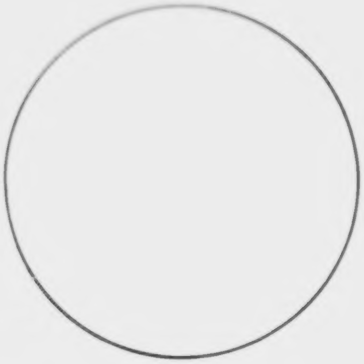
K. Construct a line parallel to and 1" above line AB.



L. Construct an equilateral triangle between the given lines AB and CD.

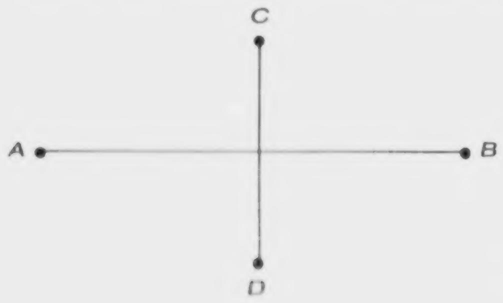


M. Find the center of the given circle.



ASSIGNMENT SHEET #1

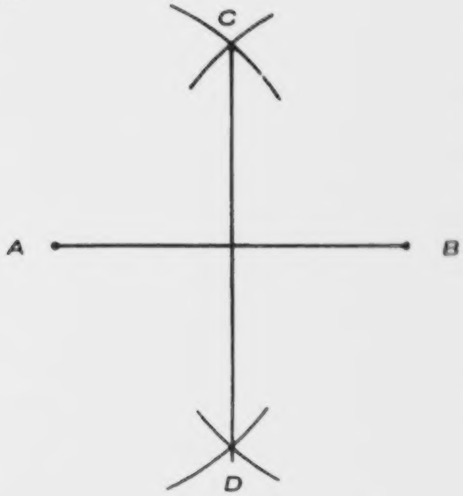
N. Draw an ellipse to the given major axis AB and the minor axis CD.



SHEET METAL LAYOUT
UNIT III

ANSWERS TO ASSIGNMENT SHEET #1

A.



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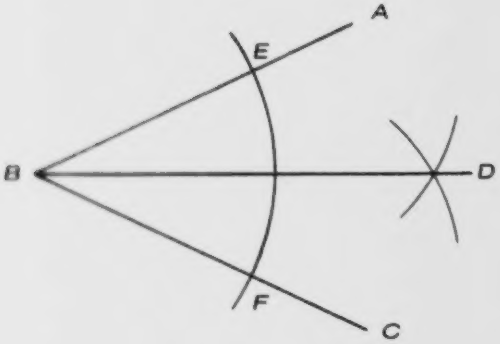

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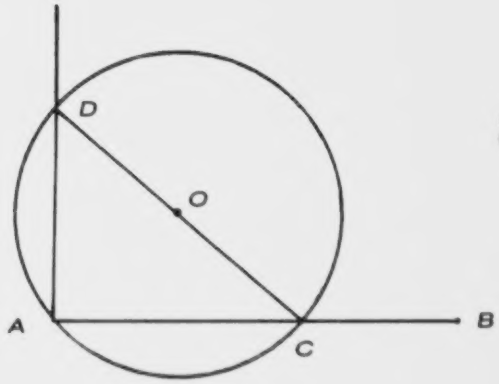
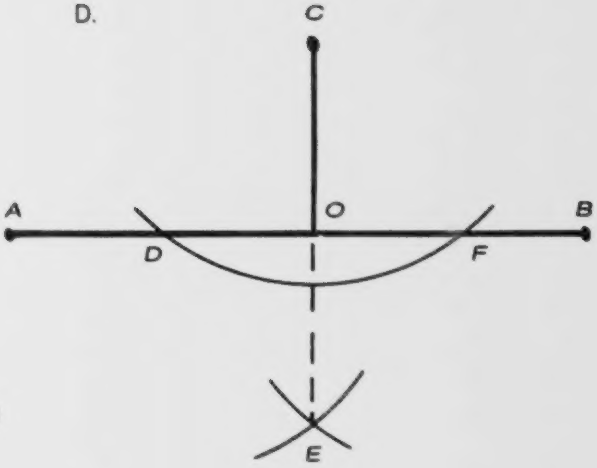
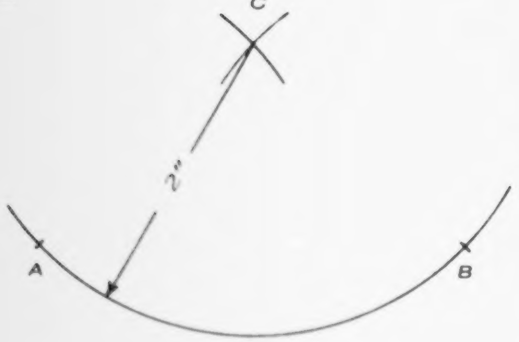


D.



ANSWERS TO ASSIGNMENT SHEET

E.



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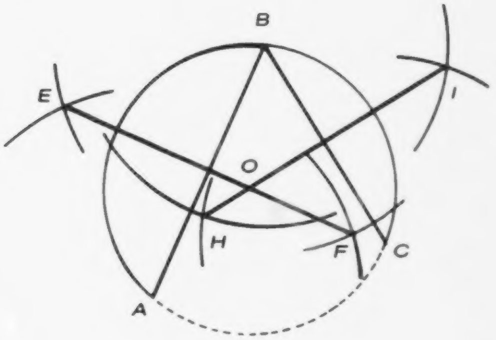

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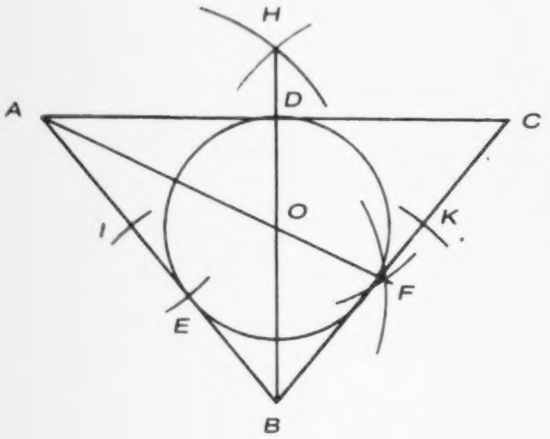
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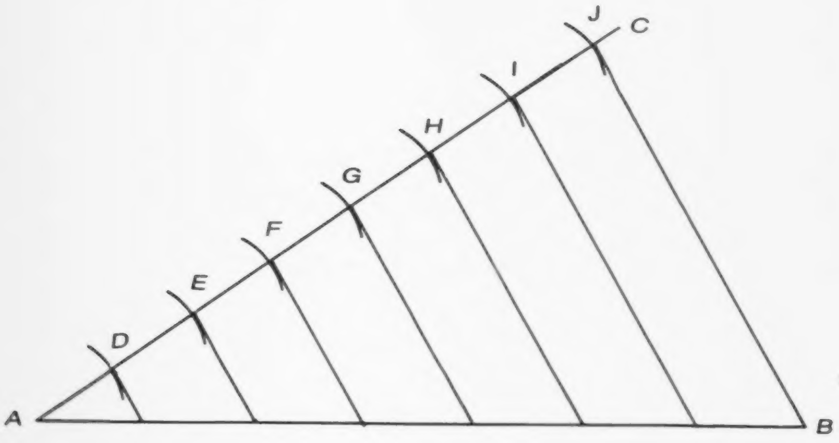
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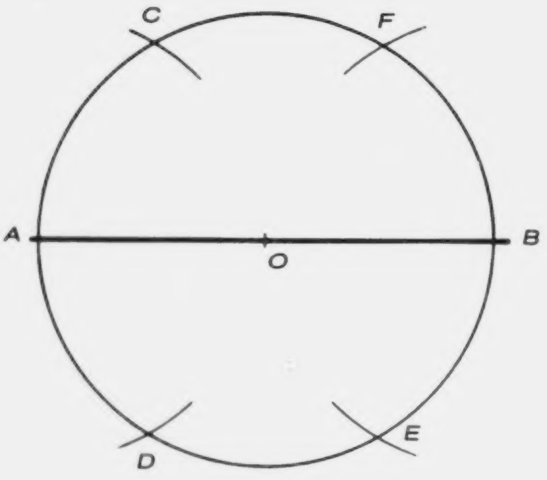
ANSWERS TO ASSIGNMENT SHEET

I.



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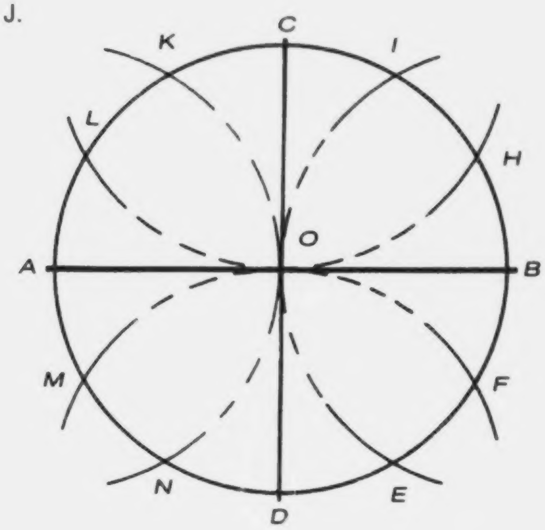
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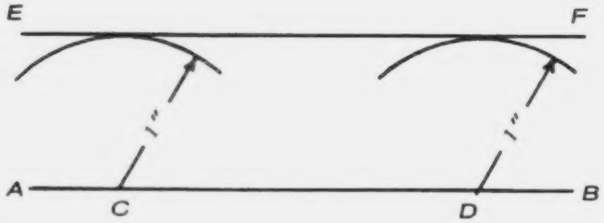

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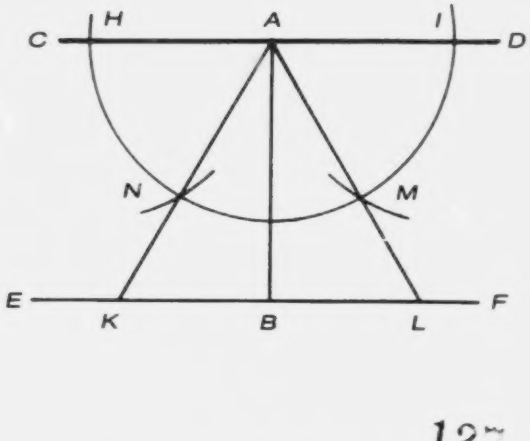
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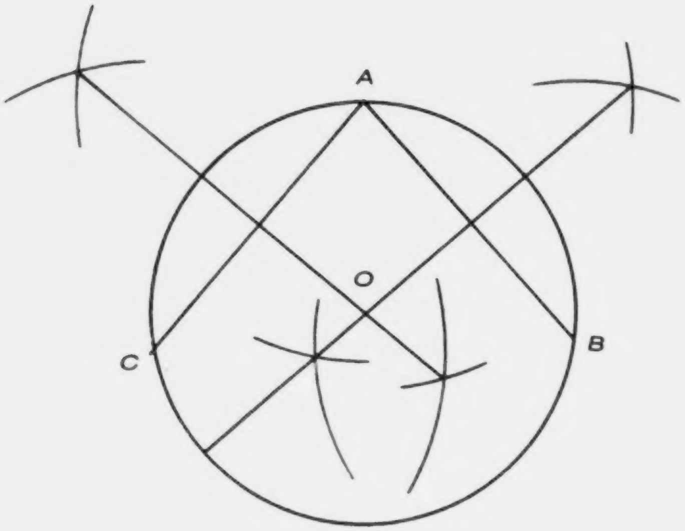
ANSWERS TO ASSIGNMENT SHEET

M.



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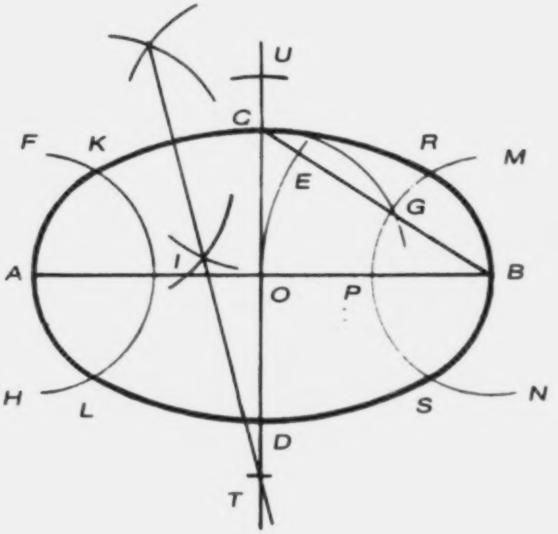
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SHEET METAL LAYOUT
UNIT III

JOB SHEET #1 — LAY OUT TO SPECIFICATIONS A METAL BOX

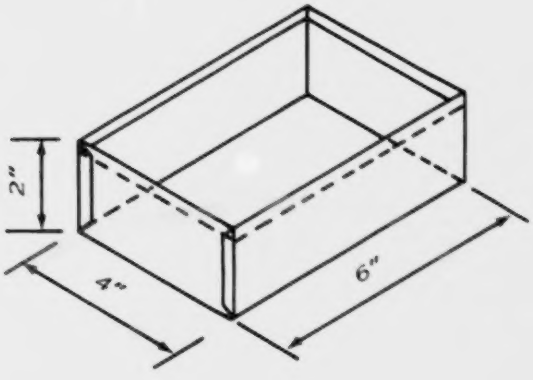
I. Tools and materials

- A. Folding rule
- B. Straightedge
- C. Scratch awl
- D. Square
- E. Protractor
- F. Sheet metal as selected by instructor

II. Procedure

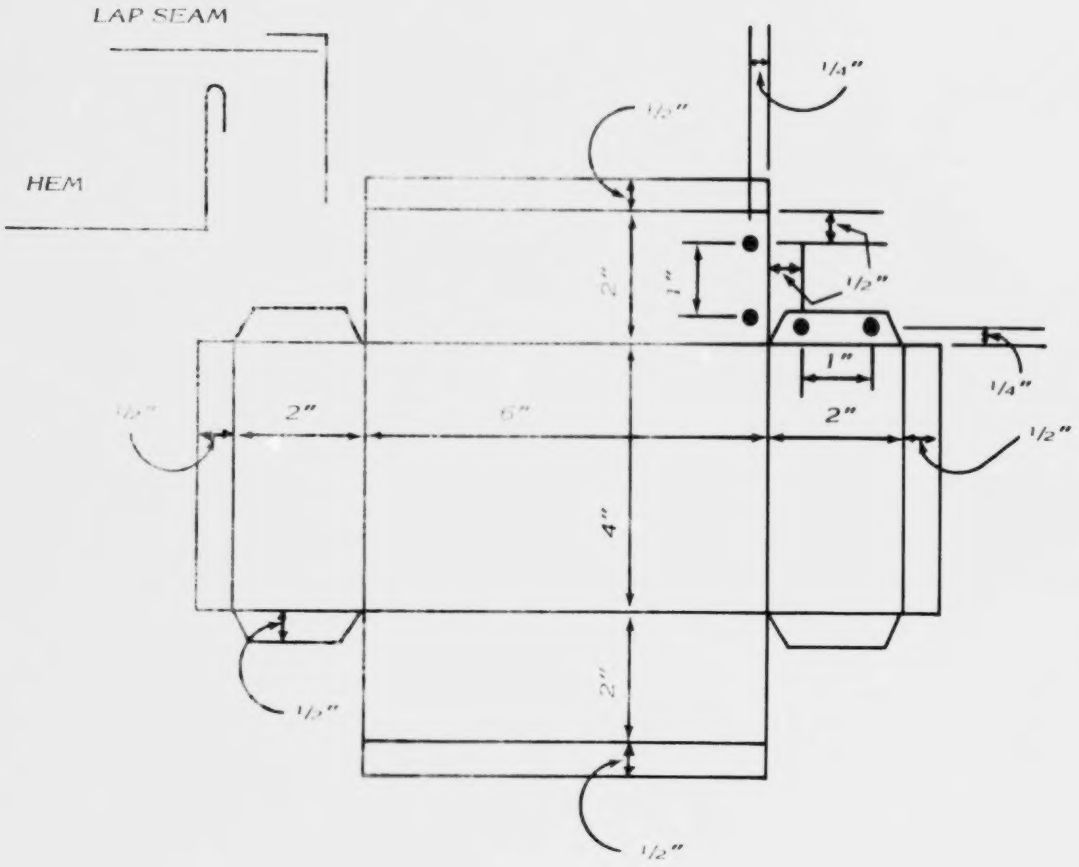
- A. Study the isometric view (Figure 29) and Figure 30 on the next page

FIGURE 29: Isometric view



JOB SHEET #1

FIGURE 30


LAP SEAM
HEM
1/4"
1/2"
2"
1"
1/2"
1/4"
1"
1/2"
2"
6"
2"
1/2"
4"
1/2"
2"
1/2"

JOB SHEET #1

B. Lay out an area 9" × 11" on a piece of sheet metal slightly larger than needed

C. Transcribe all measurements from Figure 30 to sheet metal

D. Recheck all measurements and angles

E. Have instructor check your work

F. Clean up area and put away tools and materials

SHEET METAL LAYOUT
UNIT III

JOB SHEET #2 — LAY OUT A RECTANGULAR DUCT

I. Tools and materials

  A. Folding rule

  B. Straightedge

  C. Scratch awl

  D. Square

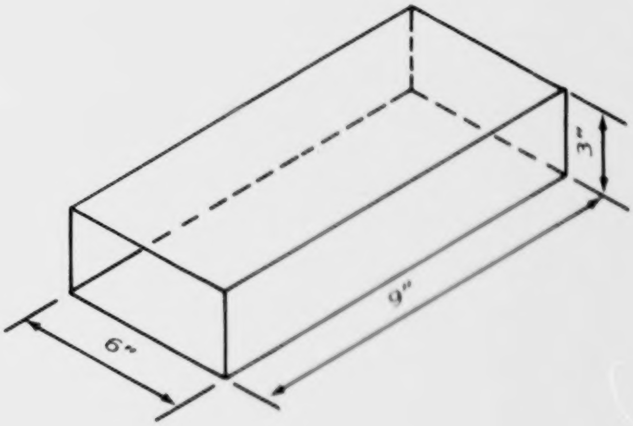
  E. Protractor

  F. Sheet metal as selected by instructor

II. Procedure

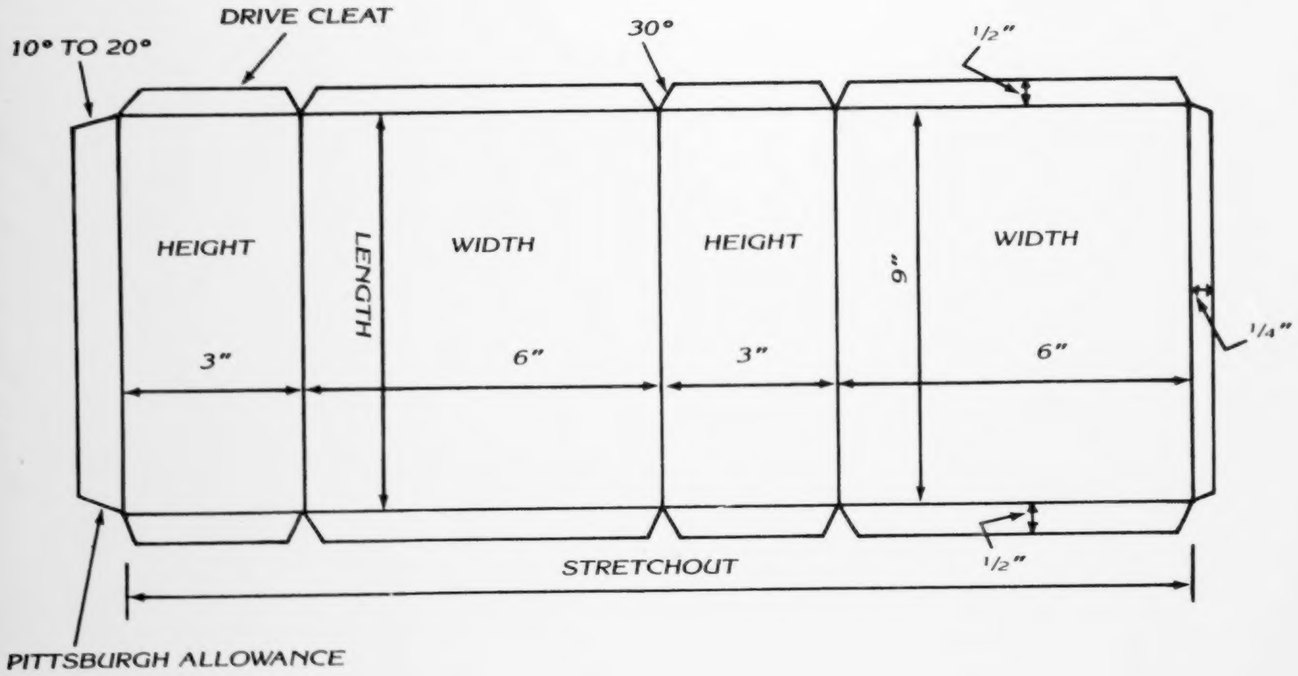
  A. Study the isometric view (Figure 31) and Figure 32 on the next page

FIGURE 31: Isometric view



JOB SHEET #2

FIGURE 32


DRIVE CLEAT
10° TO 20°
30°
1/2"
HEIGHT
LENGTH
WIDTH
HEIGHT
9"
WIDTH
1/4"
3"
6"
3"
6"
1/2"
STRETCHOUT
PITTSBURGH ALLOWANCE

JOB SHEET #2

B. Lay out an area 10" × 19 ¼" on a piece of sheet metal slightly larger than needed

C. Transcribe all measurements from Figure 32 to sheet metal

D. Recheck all measurements and angles

E. Have instructor check your work

F. Clean up area and put away tools and materials

SHEET METAL LAYOUT
UNIT III

JOB SHEET #3 — LAY OUT A CIRCLE ON SHEET METAL

I. Tools and materials

   A. Circumference rule

   B. Wing dividers

   C. Scratch awl

   D. Metal gauge

   E. 26-gauge galvanized sheet metal as selected by instructor

II. Procedure

   A. Use metal gauge to check sheet metal to be sure it is the proper gauge

   B. Lay out an area large enough for a 3" circle on a piece of sheet metal slightly larger than needed

   C. Set wing dividers for a 3" circle

   D. Scribe a 3" circle on the sheet metal

   E. Use rule to recheck measurement

   F. Have instructor check your work

   G. Clean up area and put away tools and materials

SHEET METAL LAYOUT
UNIT III

TEST

NAME ________________________ SCORE ____________

1. Match terms associated with sheet metal layout to their correct definitions. Write the correct numbers in the blanks.

______a. Outer limits or boundary

______b. Shape formed by straight or curved lines

______c. Divide into two equal parts

______d. Relating to, consisting of, or resembling a straight line

______e. Line or surface at a right angle to another line or surface

______f. Extending in the same direction an equal distance apart and never meeting

______g. Angle formed by two lines perpendicular to each other; 90 degree angle

______h. A straight line joining any two points on an arc, curve, or circumference

______i. A line or plane that touches at only one point but does not intersect a curve, an arc, or a circumference

______j. A figure having all sides equal

______k. A segment of a circle

______l. Distance around outer edge of a circle

______m. The point at which a line or a plane touches a curve, an arc, or a circumference

______n. Distance from center of a circle to any point on edge of circle

1. Parallel
2. Equilateral
3. Diameter
4. Lineal
5. Point of tangent
6. Chord
7. Pi
8. Perimeter
9. Block out
10. Right angle
11. Tangent
12. Perpendicular
13. Radius
14. Area
15. Bisect
16. Ellipse
17. Circumference
18. Geometric figure
19. Arc

TEST

______o. Greek letter (π) representing the ratio of a circle's circumference to its diameter, which is approximately 3.1416

______p. The path of a point that moves so that the sum of its distance from two fixed points is constant to create a figure that falls short of a perfect circle

______q. Distance between outer edges of a circle through center point

______r. Measure of a flat surface; expressed in square units

______s. Cut out by hand or on a square shear all the material required to complete a pattern

2. Match types of geometric figures to their descriptions. Write the correct numbers in the blanks.

______a. Figure having three sides and three angles

______b. Figure having four sides of equal length and four right angles

______c. Flat, round figure formed by one curved line; all points of curved line are equidistant from center point

______d. Figure having no right angles and four sides of equal length

______e. Figure with only one pair of parallel opposite sides

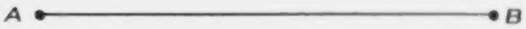
______f. Figures with two parallel ends of equal length, two parallel sides of equal length, and four right angles

______g. Figure such as a square, rectangle, or rhombus with two parallel ends of equal length and two parallel sides of equal length

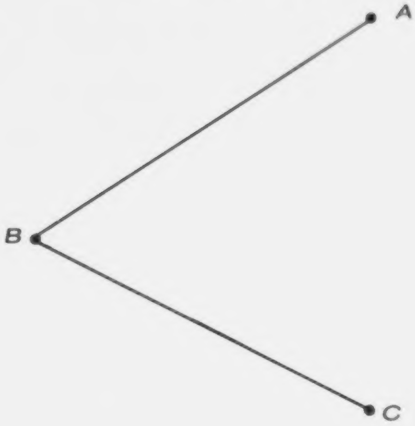
1. Circle
2. Parallelogram
3. Trapezoid
4. Triangle
5. Rectangle
6. Rhombus
7. Square

TEST

3. Bisect the following straight line.



4. Bisect the following angle.



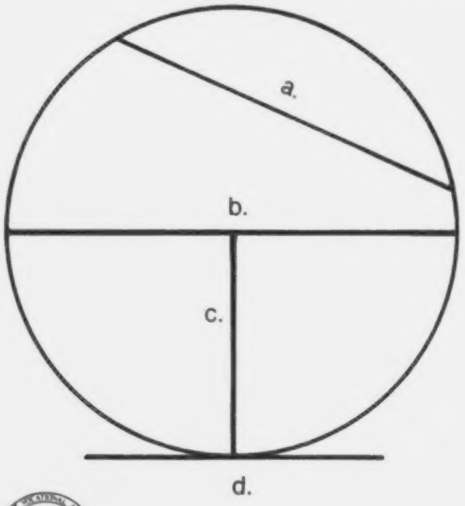
5. Lable the elements related to drawing circles. Write the correct names in the blanks.

a. ______________________

b. ______________________

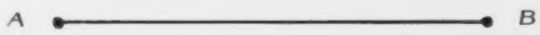
c. ______________________

d. ______________________

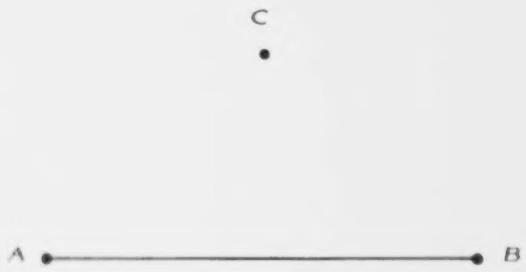


TEST

6. Erect a perpendicular at the end of the straight line AB at point A.

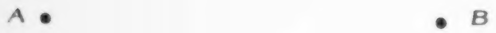


7. Erect a perpendicular from point C to line AB.

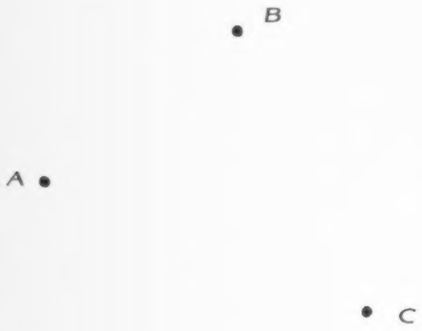


TEST

8. Pass an arc with a 2″ radius through points A and B.

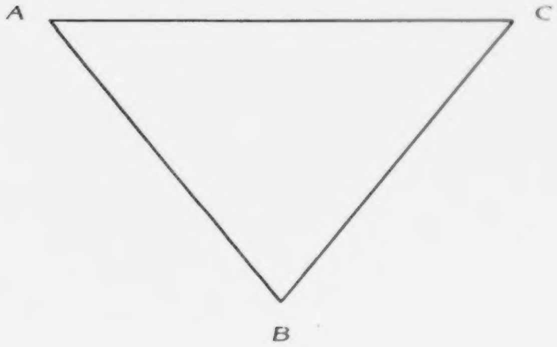


9. Pass an arc through the three points A, B and C.

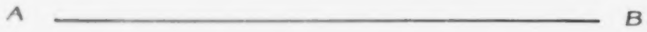


TEST

10. Inscribe a circle within the triangle ABC.

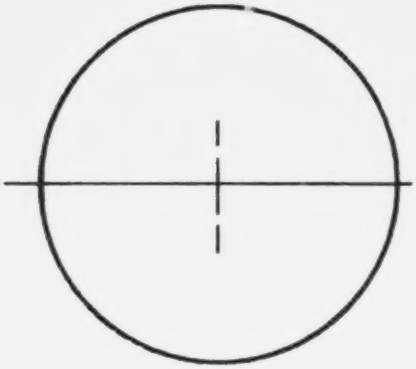


11. Divide the line AB into five equal parts.

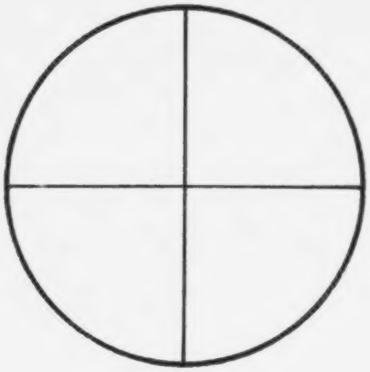


TEST

12. Divide the given circle into six equal parts.

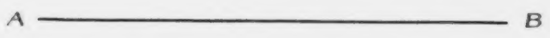


13. Divide the given circle into twelve equal parts.

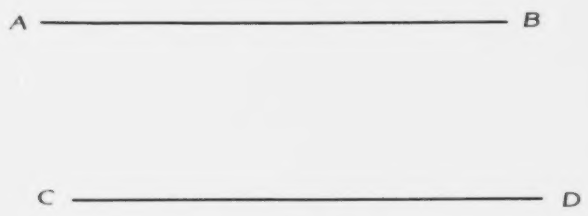


TEST

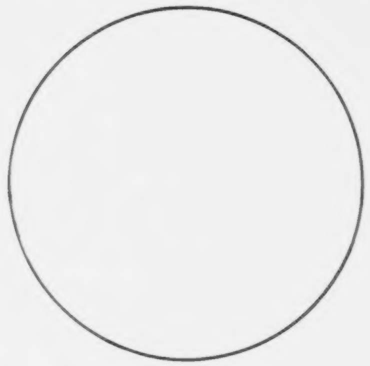
14. Construct parallel lines by drawing a line parallel to and 1" above line AB.



15. Construct an equilateral triangle between the given lines AB and CD.

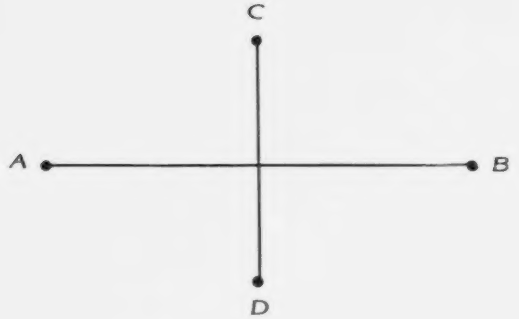


16. Find the center of the given circle.

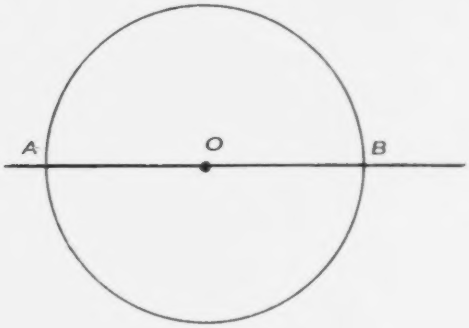


TEST

17. Draw an ellipse using the line AB as a major axis and line CD as a minor axis.



18. Create approximate 30-degree and 60-degree angles with a compass below center point 0 in the given circle.



TEST

(NOTE: Test items 19 and 20 list the assignment and job sheets. They are an important part of this test. If they have not been completed, check with your instructor.)

19. Practice drawing basic geometric constructions.

20. Demonstrate the ability to

    a. Lay out to specifications a metal box.

    b. Lay out a rectangular duct.

    c. Lay out a circle on sheet metal.

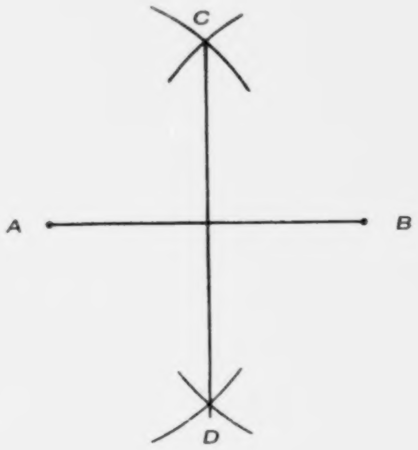
SHEET METAL LAYOUT
UNIT III

ANSWERS TO TEST

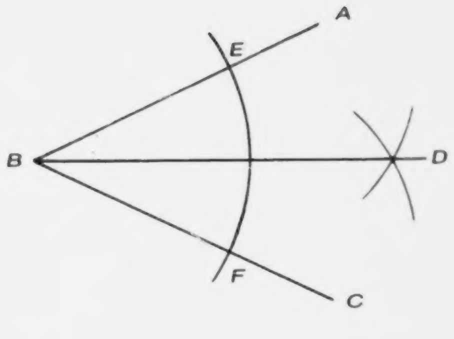
1. a. 8
   b. 18
   c. 15
   d. 4
   e. 12
   f. 1
   g. 10
   h. 6
   i. 11
   j. 2
   k. 19
   l. 17
   m. 5
   n. 13
   o. 7
   p. 16
   q. 3
   r. 14
   s. 9

2. a. 4
   b. 7
   c. 1
   d. 6
   e. 3
   f. 5
   g. 2

3.



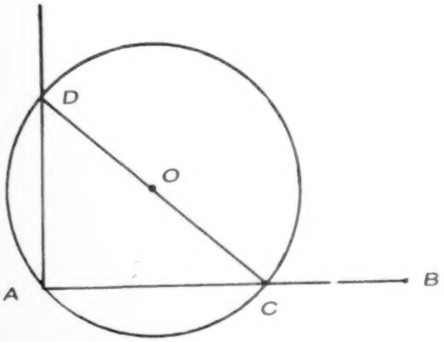
4.



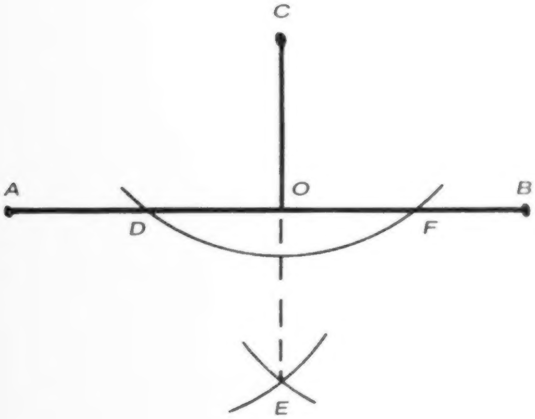
ANSWERS TO TEST

5. a. Chord c. Radius
   b. Diameter d. Tangent

6.

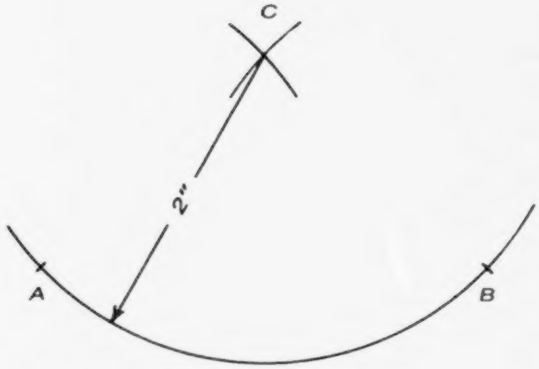


7.



ANSWERS TO TEST

8.



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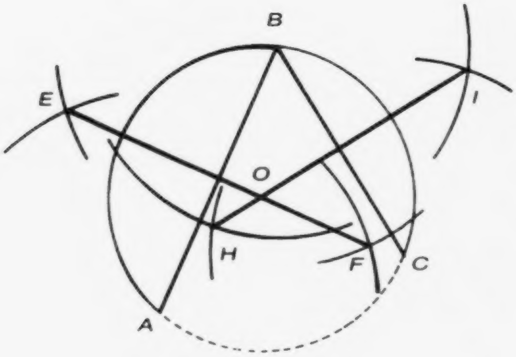
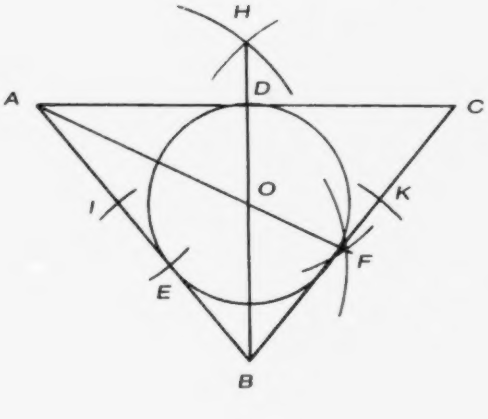


10.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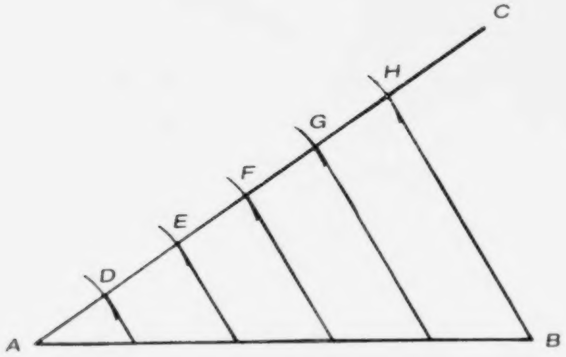
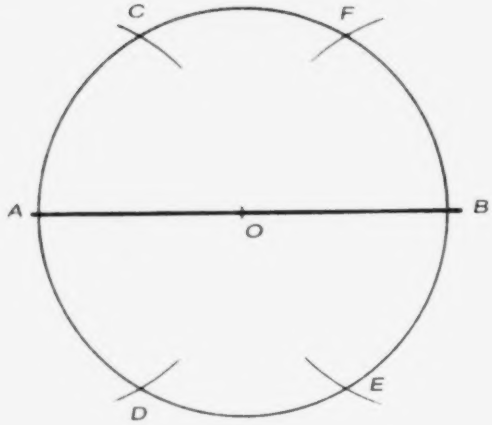
ANSWERS TO TEST

11.

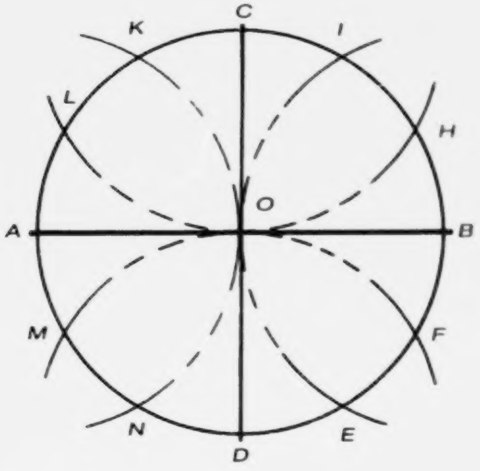


12.



ANSWERS TO TEST

13.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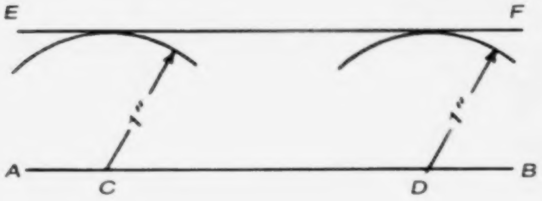
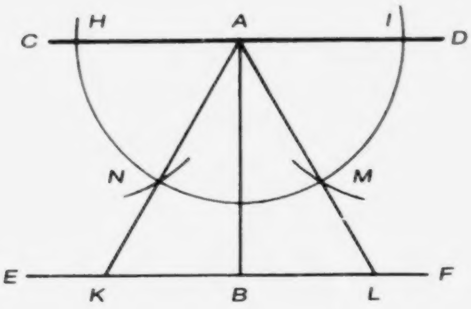
14.



15.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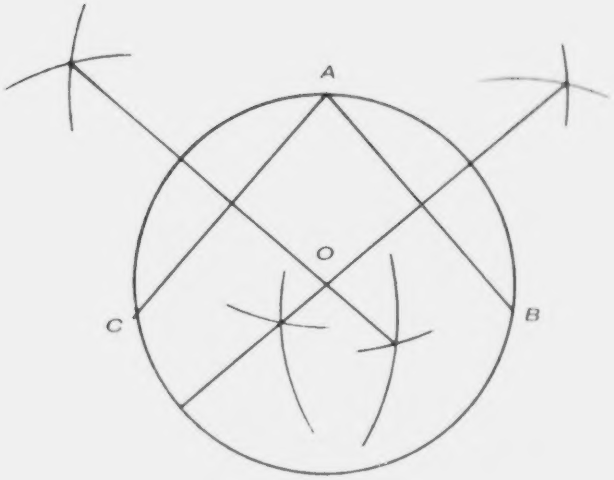
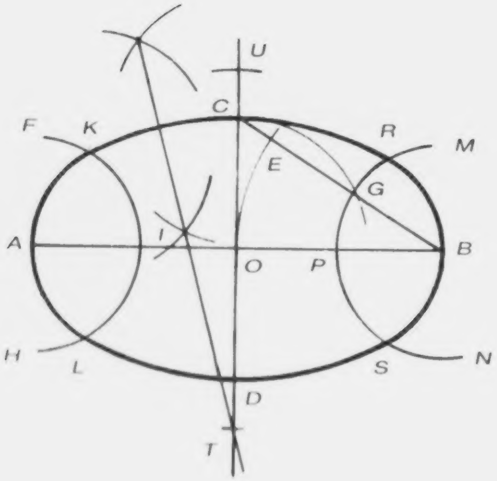
ANSWERS TO TEST

16.



17.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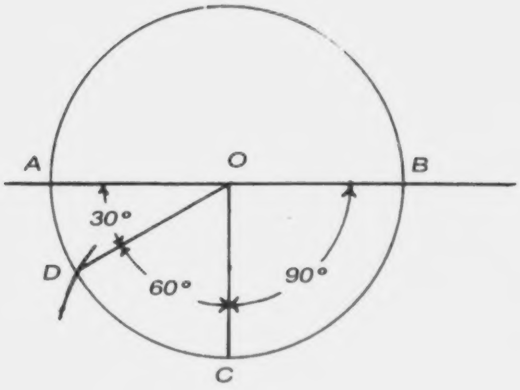
ANSWERS TO TEST

18.



19. Evaluated to the satisfaction of the instructor.

20. Performance skills evaluated to the satisfaction of the instructor.

SHEET METAL BASIC SKILLS
UNIT IV

UNIT OBJECTIVE

After completing this unit, the student should be able to identify various types of seams, hems, locks, clips, notches, and sheet metal fittings. The student should also be able to perform basic skills such as cutting sheet metal, constructing a metal box, a rectangular duct, and assembling a cylinder to a flat surface. The student will show this ability by completing the job sheets and unit test with a minimum score of 80 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match terms associated with sheet metal basic skills to their definitions.
2. Identify basic types of seams.
3. Identify basic types of hems.
4. Identify basic types of locks.
5. Identify basic types of clips.
6. Match basic types of notches to their descriptions.
7. Identify basic types of sheet metal fittings.
8. Demonstrate the ability to
    a. Lay out, then cut with straight snips a 4" × 3" metal rectangle.
    b. Lay out, then cut with left-cutting snips a 3-inch metal circle.
    c. Lay out, then cut with right-cutting snips a 3-inch metal circle.
    d. Lay out and form to specifications a metal box.
    e. Lay out and form to specifications a rectangular duct.
    f. Lay out and cut sheet metal for a cylinder, then join cylinder to a flat surface with a dovetail notch.

SHEET METAL BASIC SKILLS
UNIT IV

SUGGESTED ACTIVITIES

I. Unit contents

   A. Objective sheet

   B. Suggested activities

   C. Transparency masters

      1. TM #1 — Duct Installation Using S and Drive Clips

      2. TM #2 — Types of Notches

      3. TM #3 — Dovetail Notch in Cylinder to Flat Surface Application

   D. Information sheet

   E. Job sheets

      1. Job Sheet #1 — Lay Out, Then Cut with Straight Snips a 4" × 3" Metal Rectangle

      2. Job Sheet #2 — Lay Out, Then Cut with Left-Cutting Snips a 3-Inch Metal Circle

      3. Job Sheet #3 — Lay Out, Then Cut with Right-Cutting Snips a 3-Inch Metal Circle

      4. Job Sheet #4 — Lay Out and Form to Specifications a Metal Box

      5. Job Sheet #5 — Lay Out and Form to Specifications a Rectangular Duct

      6. Job Sheet #6 — Lay Out and Cut Sheet Metal for a Cylinder, then Join Cylinder to a Flat Surface with a Dovetail Notch

   F. Test

   G. Answers to test

II. Instructor's guide

   A. Review unit and plan presentation.

   B. Obtain tools and materials necessary to accomplish procedures in job sheets.

   C. Introduce unit to students.

SUGGESTED ACTIVITIES

D. Provide students with objective sheet.

E. Discuss unit and specific objectives.

F. Provide student with information and job sheets.

G. Discuss information and job sheets.

1. Use Information Sheet, Section I, to discuss terms and definitions associated with sheet metal basic skills.
    - Have students review terms.
    - Show examples of as many terms as possible.
    - Relate the terms to pertinent sections of the information sheet for more detailed descriptions of construction and uses.
2. Use Information Sheet, Section II, to discuss basic types of seams.
    - Provide samples of each type of seam.
    - Discuss proper use of the seams, how and where they are used.
    - Allow students to examine and become familiar with each different type of seam.
3. Use Information Sheet, Section III, to discuss basic types of hems.
    - Provide samples of each type of hem and, if possible, the various types of other edges.
    - Explain to the students that hems are also types of edges.
    - Discuss the purpose of hems and edges.
    - Discuss how the various types of edges are formed.
    - Discuss the differences in the various types.
4. Use Information Sheet, Sections IV and V, to discuss basic types of locks and clips.
    - Provide samples of the locks and various types of clips.
    - Explain how the locks and clips are used.
    - Demonstrate how the clips lock sections of duct work together.

SUGGESTED ACTIVITIES

- Show Transparency #1 to reinforce your discussion and demonstration.

5. Use Information Sheet, Section VI, to discuss types of notches.
   - Show Transparencies #2 and #3.
   - Point out on the transparencies the various types of notches.
   - Discuss how and when these notches are used.
   - Relate these notches to the ones used in Job Sheets #4, #5, and #6 of this unit.
6. Use Information Sheet, Section VII, to discuss basic types of sheet metal fittings.
   - Provide samples of the various types of sheet metal fittings.
   - Allow students to examine and become familiar with each of the different types of fittings.
   - Lay out a display of the different types of fittings and have the students identify each one by writing the name of each one.
7. Demonstrate procedures listed in the job sheets.
8. Have students demonstrate the procedures, then have them complete each of the job sheets.
9. Continue to emphasize the importance of safety when working with sheet metal, hand tools, and power tools.

H. Post appropriate warning signs and operating procedures near all equipment.

I. Caution students that noncompliance with safety rules will result in disciplinary action.

J. Give test.

K. Critique test and discuss in class.

L. Reteach and retest as necessary.

M. Complete appropriate section of competency profiles.

(NOTE: A master of the competency profile for this book is provided at the front of the instructor edition. You may duplicate the profile and distribute it to students as needed.)

SUGGESTED ACTIVITIES

III. Unit references

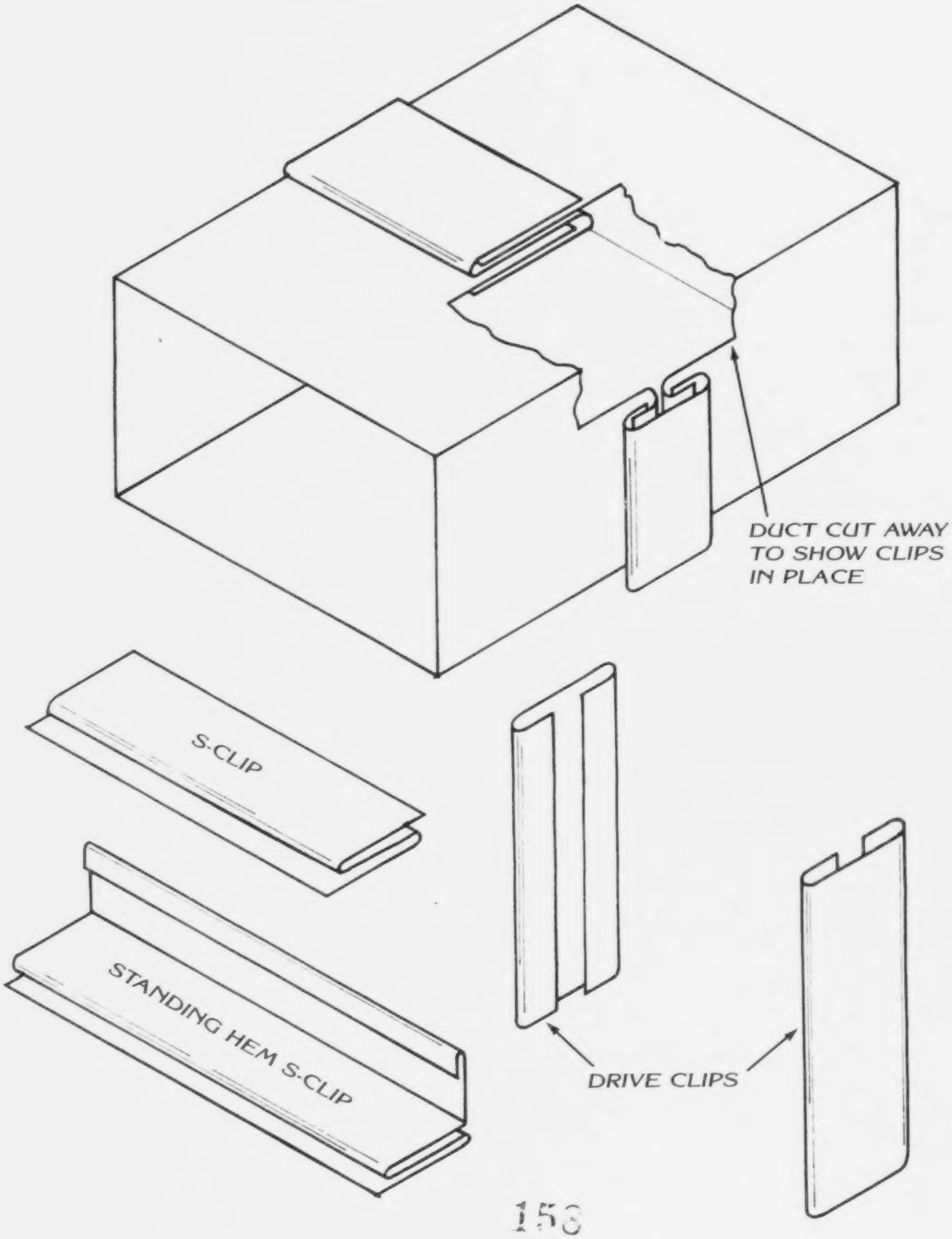
   A. Jones, Leonard and Morse, Otto. *Sheet Metal Basics*. Stillwater, Oklahoma: Mid-America Vocational Curriculum Consortium, Inc. 1983.

   B. Jones, Leonard and Morse, Otto. *Basic Sheet Metal Layout and Fabrication*. Stillwater, Oklahoma: Mid-America Vocational Curriculum Consortium, Inc. 1983.

   C. Zinngrabe, Claude J. *Sheet Metal Blueprint Reading for the Building Trades*. Albany, New York: Delmar Publishers, A Division of Litton Educational Publishing, Inc. 1980.

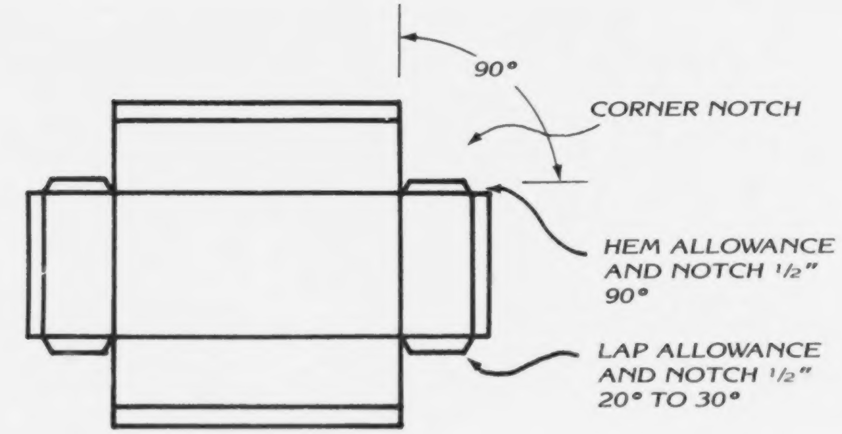
ITSM-167

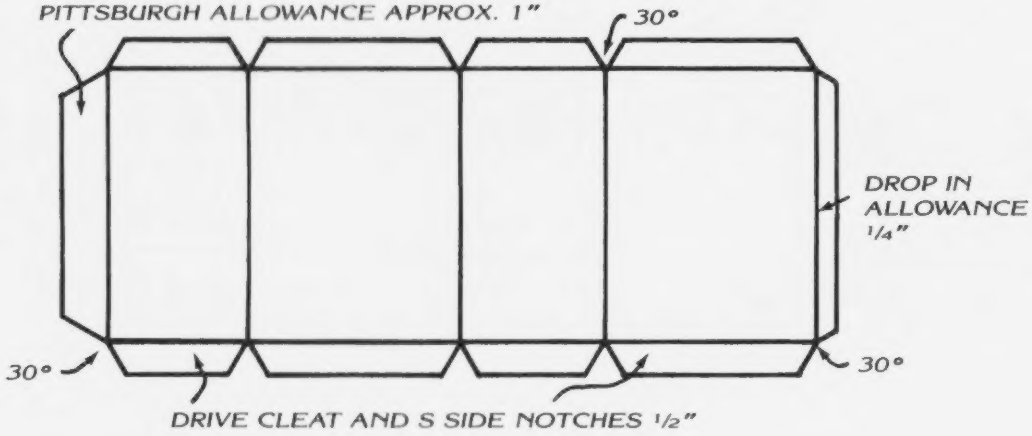
Duct Installation Using S and Drive Clips

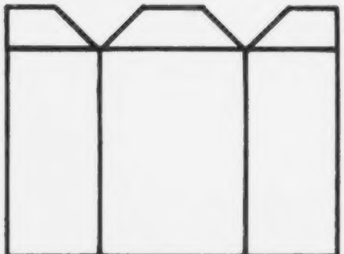

DUCT CUT AWAY TO SHOW CLIPS IN PLACE
S-CLIP
STANDING HEM S-CLIP
DRIVE CLIPS

THE ASSOCIATED GENERAL CONTRACTORS OF AMERICA

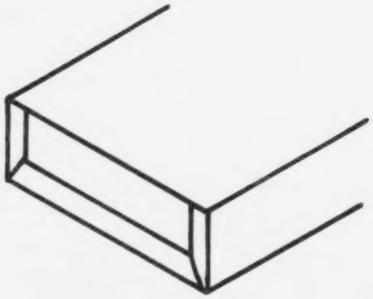
Types of Notches


90°
CORNER NOTCH
HEM ALLOWANCE AND NOTCH 1/2" 90°
LAP ALLOWANCE AND NOTCH 1/2" 20° TO 30°


PITTSBURGH ALLOWANCE APPROX. 1"
30°
DROP IN ALLOWANCE 1/4"
30°
30°
DRIVE CLEAT AND S SIDE NOTCHES 1/2"

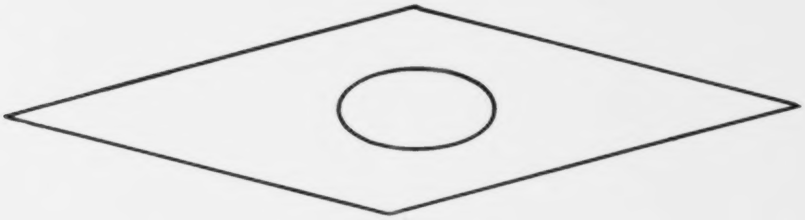


LAP SEAM FOR 3-PIECE BOX

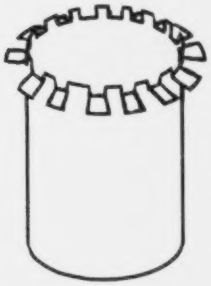


FINISHED SEAM

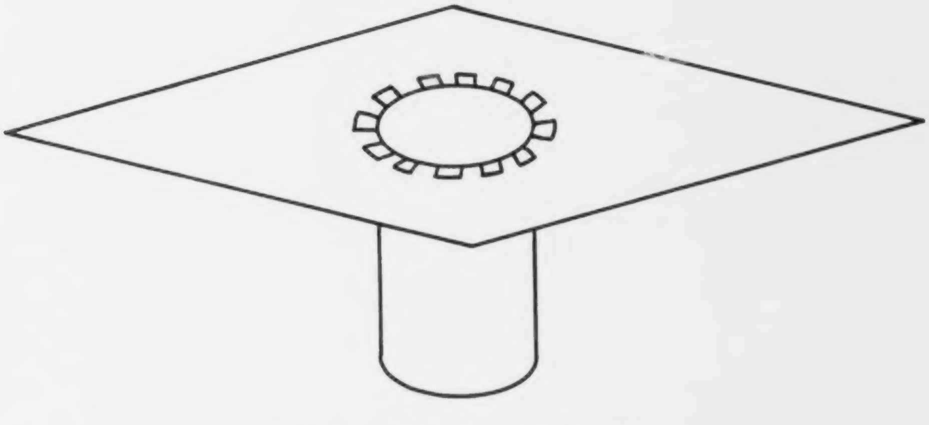
Dovetail Notch in Cylinder to Flat Surface Application



HOLE FOR DOVETAIL



DOVETAIL NOTCH



FINISHED DOVETAIL SEAM

SHEET METAL BASIC SKILLS
UNIT IV

INFORMATION SHEET

I. Terms and definitions associated with sheet metal basic skills

- A. **Seam** — Procedure or method by which two pieces of metal are joined together
- B. **Lock** — Similar to seam; usually refers to applications where ends of ducts are joined or where bottoms of pans or boxes are formed

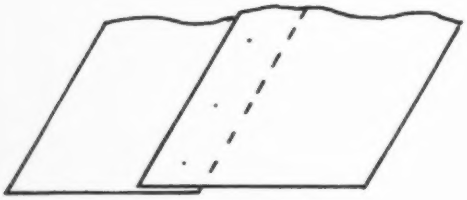
  (NOTE: The definitions of *seam, lock,* and *joint* may vary in different parts of the country.)

- C. **Clip** — Piece or pieces of metal formed specifically for holding two or more sections of duct together
- D. **Edge** — Procedure or method of stiffening or adding strength to the edge of a piece of metal by reforming the metal or adding preformed metal to eliminate raw edges
- E. **Notch** — Angle cut in the edge of a piece of metal to facilitate the forming of seams, hems, and joint allowances
- F. **Joint** — Any point where two pieces of round or rectangular duct join together or where fittings join duct
- G. **Tab** — Material intended to be bent for an anchoring point or a lap allowance
- H. **Tap in** — Lock formed by placing one piece of duct inside another and securing it from inside with dovetailed tabs

II. Basic types of seams (Figures 1-7)

- A. Lap seam — Seam most commonly used on small projects such as short, round cylinders; can be spot welded, riveted, or soldered

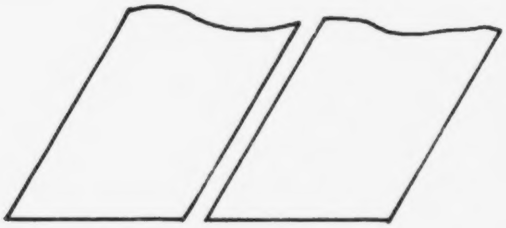
FIGURE 1



INFORMATION SHEET

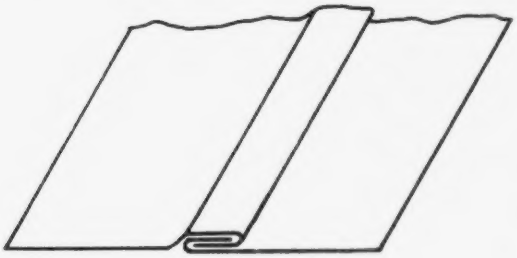
B. Butt seam — Used when two pieces of metal are joined without overlapping; can be soldered or welded

FIGURE 2



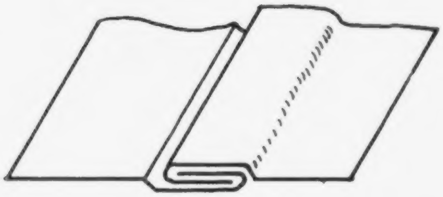
C. Grooved lock seam — Formed on a brake so that two hems can be clipped together and closed with a hand groover

FIGURE 3



D. Acme or hammerlock pipe seam — Formed on a lock former, then clipped together and hammered down with a mallet; used when making long lengths of round pipe

FIGURE 4

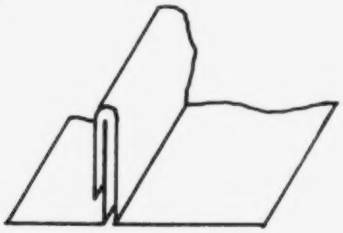


INFORMATION SHEET

E. Standing seam — Used to support edges of long spans such as metal roofs, awnings, and canopies

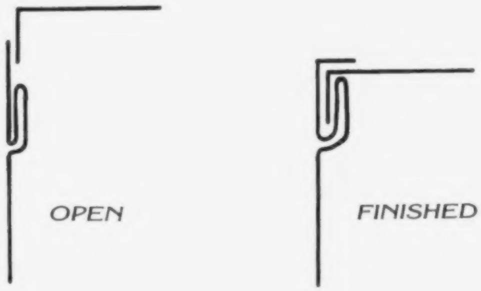
(NOTE: Standing seams require waterproofing and should be secured with solder or rivets.)

FIGURE 5



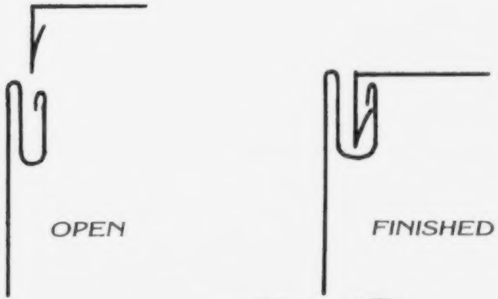
F. Pittsburgh seam — Formed on a Pittsburgh machine or made on a brake; most commonly used on rectangular duct

FIGURE 6



G. Snap-lock Pittsburgh seam — Used on rectangular duct in high production applications; formed on a special Pittsburgh machine and put together by hand or with a mallet

FIGURE 7

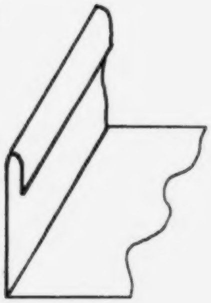


INFORMATION SHEET

III. Basic types of hems (Figures 8-11)

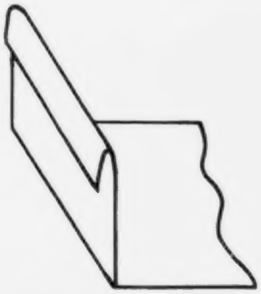
A. Inside hem — Formed on a brake or bar folder with a small amount of metal turned down 180-degrees on the inside to form a smooth edge and add strength and stiffness

FIGURE 8



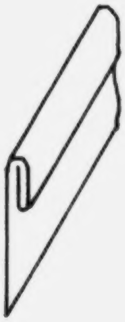
B. Outside hem — Formed on a brake or bar folder with a small amount of metal turned down 180-degrees on the outside to form smooth edge and add strength and stiffness

FIGURE 9



C. Double hem — Formed like a single hem, but doubled when extra support is required

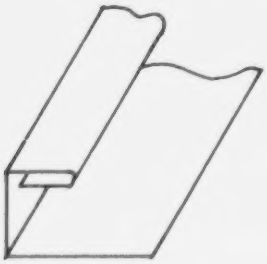
FIGURE 10



INFORMATION SHEET

D. Standing hem — A hem with an added 90-degree angle to add strength and stiffness for support or shaping

FIGURE 11

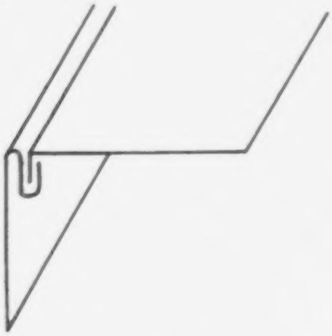


IV. Basic types of locks (Figures 12 and 13)

A. Coffin lock — Used to form a neat, square outside corner in an application where the inside is hidden and does not require special finishing

EXAMPLE: On a canopy where the outside is exposed, coffin locks can be soldered and neatly finished to form a neat-looking hidden seam.

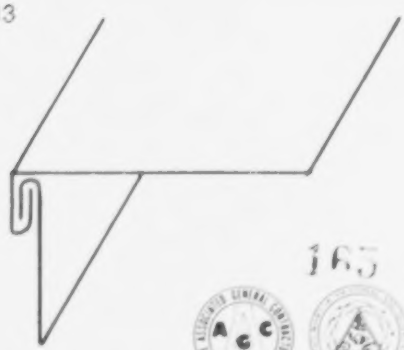
FIGURE 12



B. Sliplock — Used to form a neat square, inside corner in an application where the outside is not critical and does not require special finishing

EXAMPLE: The bottoms of many pans are formed with sliplocks.

FIGURE 13

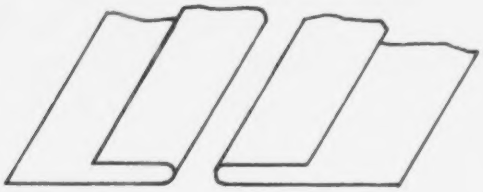


INFORMATION SHEET

V. Basic types of clips (Figures 14-17)

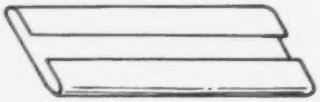
A. Edges for connecting drive clips — ½-inch edge formed with a cleat bender on the short side of preformed duct

FIGURE 14



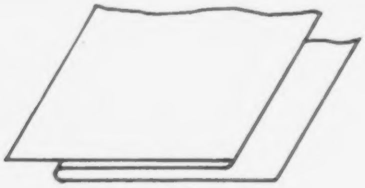
B. Drive clip — Usually hammered onto the preformed edges of duct to hold two pieces of duct together

FIGURE 15



C. S-clip — Shaped somewhat like the letter "S" and used along the long side of pieces of duct to join them together and to prevent loss of air at these points

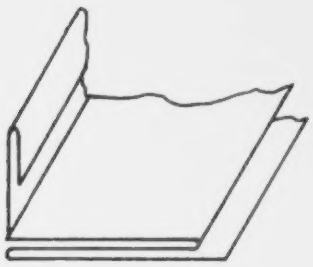
FIGURE 16



INFORMATION SHEET

D. Standing hem S-clip — Used for providing extra support in applications of extra-wide duct

FIGURE 17



VI. Basic types of notches

A. Corner notch — Used on corners of boxes and pans when the sides bend 90-degrees from the bottom

B. Lap notch — A notch angled 20- to 30-degrees; designed to overlap corners; usually secured by spot welding or riveting

C. Duct notch — A notch angled at approximately 30 degrees; used on all corners and sides in duct work

D. 45-degree lap notch — A notch angled at exactly 45 degrees to give a picture frame appearance

E. Center Pittsburgh notch — A 30-degree V-shaped notch made on the Pittsburgh side where the metal will be bent across a seam

CAUTION

To avoid leaving a hole in the finished application, *never* cut full depth.

F. Corner Pittsburgh notch for transitional duct — A 30-degree notch 1/2 inch deep angling into a straight notch which joins the seam allowance line only on transitional duct

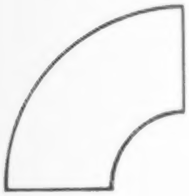
G. Dovetail notch — Used for connecting round pipe to a rectangular duct or flat sheet

INFORMATION SHEET

VII. Basic types of sheet metal fittings (Figures 18-29)

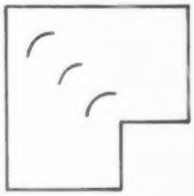
A. Curved-throat elbow

FIGURE 18



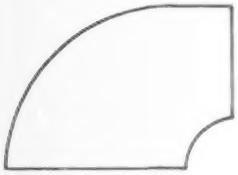
B. Square-throat elbow

FIGURE 19



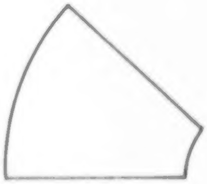
C. Change elbow

FIGURE 20



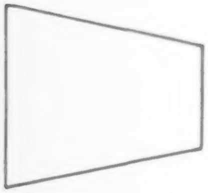
D. Angle

FIGURE 21



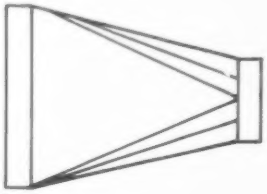
E. Transition

FIGURE 22



F. Square to round transition

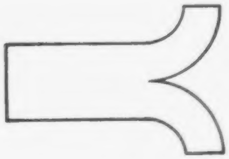
FIGURE 23



INFORMATION SHEET

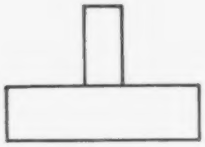
G. Y-branch

FIGURE 24



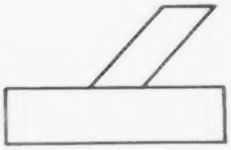
H. Tee

FIGURE 25



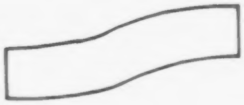
I. Angle tee

FIGURE 26



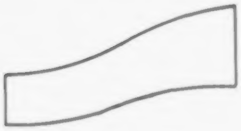
J. Offset

FIGURE 27



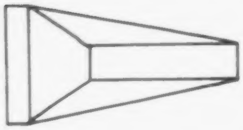
K. Change offset

FIGURE 28



L. Boot

FIGURE 29



INTRODUCTION TO SHEET METAL
UNIT IV

JOB SHEET #1 — LAY OUT, THEN CUT WITH STRAIGHT SNIPS A 4" × 3" METAL RECTANGLE

I. Tools and materials

A. Straight snips

B. Circumference rule

C. Scratch awl

D. 26-gauge galvanized metal as selected by instructor

II. Procedure

A. Measure and scribe a 4" × 3" rectangle on the galvanized sheet

(NOTE: You may be working with scrap, but even so, avoid wasting metal.)

B. Place the snips over one edge of the metal until the metal reaches the V in the snip jaws

C. Begin cutting, but be careful not to make full cut; in other words, cut about three-fourths the length of the snip jaws

(NOTE: This is the first step in developing good cutting techniques; making a full stroke of the jaws with the snips will leave a fishhook at the end of the cut.)

D. Continue cutting with the jaws making short strokes until reaching the end of the scribe line or the end of the metal

E. Repeat the same cutting procedure on the other side of the layout

F. Continue cutting the layout until the 4" × 3" rectangle has been cut out, making smooth, short cuts with the straight snips to avoid leaving fishhooks

G. Inspect the rectangle for clean edges, then have your instructor check your work

H. Return tools and materials to proper storage areas

INTRODUCTION TO SHEET METAL
UNIT IV

JOB SHEET #2 — LAY OUT, THEN CUT WITH LEFT-CUTTING SNIPS A 3-INCH METAL CIRCLE

I. Tools and materials

   A. Left-cutting snips

   B. Wing dividers

   C. Scratch awl

   D. Circumference rule

   E. 26-gauge galvanized metal

II. Procedure

   A. Measure and scribe a 3-inch circle on the galvanized sheet

   (NOTE: Avoid wasting material.)

   B. Place the left-cutting snips over an appropriate starting point until the metal reaches the V in the snips jaws

   (NOTE: Twist the left-cutting snips firmly to the right to keep from ruining the snips.)

   C. Begin cutting, but be careful not to make a full cut; in other words, cut about three-fourths the length of the snips jaws

   D. Continue cutting, keeping continuous pressure to the right, and in short, firm strokes until the circle is completely cut out

   E. Inspect the circle for clean edges, then have your instructor check your work

   F. Return tools and materials to proper storage areas

INTRODUCTION TO SHEET METAL
UNIT IV

JOB SHEET #3 — LAY OUT, THEN CUT WITH RIGHT-CUTTING SNIPS A 3-INCH METAL CIRCLE

I. Tools and materials

A. Right-cutting snips

B. Wing dividers

C. Scratch awl

D. Circumference rule

E. 26-gauge galvanized metal as selected by instructor

II. Procedure

A. Measure and scribe a 3-inch circle on the galvanized sheet

B. Place the right-cutting snips over an appropriate starting point until the metal reaches the V in the snips jaws

(NOTE: Twist the right-cutting snips firmly to the left to keep from ruining the snips.)

C. Begin cutting, but be careful not to make a full cut; in other words, cut about three-fourths the length of the snips jaws

D. Continue cutting, keeping continuous pressure to the left, and in short, firm strokes until the circle is completely cut out

E. Inspect the circle for clean edges, then have your instructor check your work

F. Return tools and materials to proper storage areas

INTRODUCTION TO SHEET METAL
UNIT IV

JOB SHEET #4 — LAY OUT AND FORM TO SPECIFICATIONS A METAL BOX

I. Tools and materials

A. Scratch awl

B. Folding rule

C. Straightedge

D. Bulldog snips

E. Right- and left-cutting snips

F. Rivet set or pop-rivet gun

G. Sheet metal hammer

H. Floor and hand tools as required for finishing

I. Sheet metal as selected by instructor

II. Procedure (See Figures 30 and 31)

A. Block out 9" × 11" area on selected sheet metal

B. Transcribe all measurements from Figure 31 to sheet metal

C. Cut out pattern as indicated in Figure 31

D. Select hand or floor tools appropriate to specifications and form and finish the box

(NOTE: When in doubt about tool selection or forming procedure, ask your instructor for assistance.)

E. Have your instructor check your work

F. Return tools and materials to proper storage areas

JOB SHEET #4

FIGURE 30: Isometric view

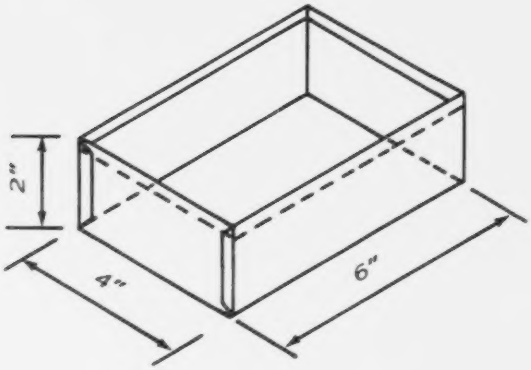
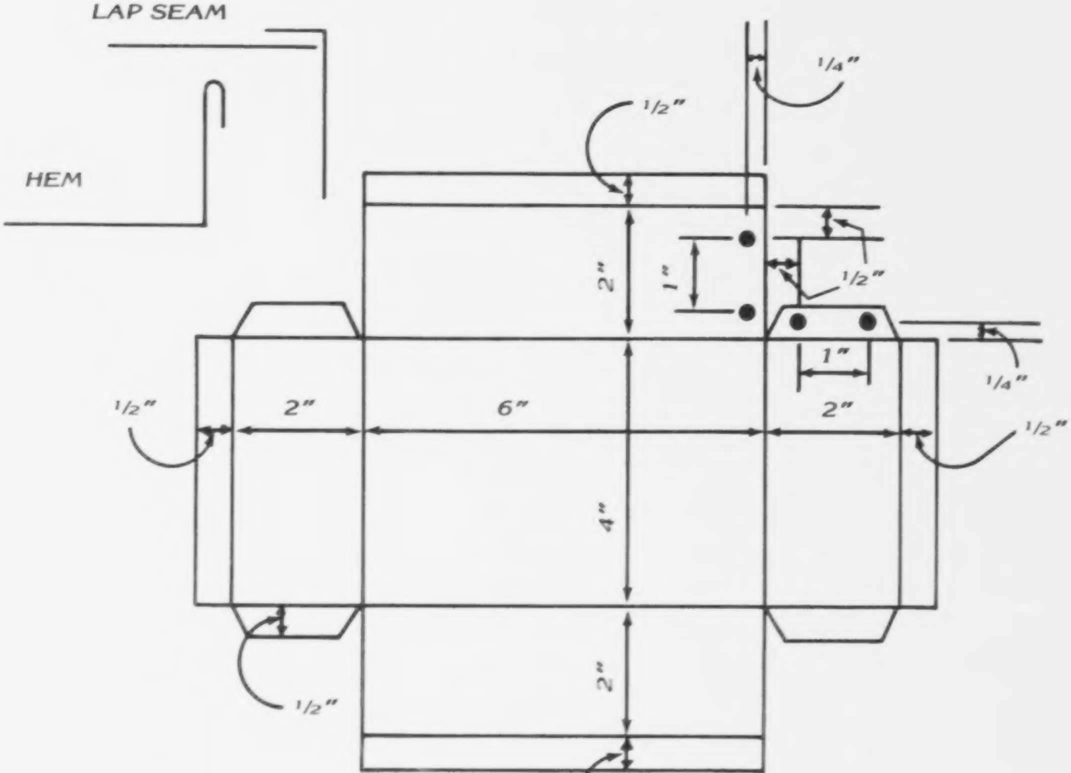


FIGURE 31


LAP SEAM
HEM
1/4"
1/2"
2"
1"
1/2"
1"
1/4"
1/2"
2"
6"
2"
1/2"
4"
1/2"
2"
1/2"

INTRODUCTION TO SHEET METAL
UNIT IV

JOB SHEET #5 — LAY OUT AND FORM TO SPECIFICATIONS A RECTANGULAR DUCT

I. Tools and materials

   A. Scratch awl

   B. Folding rule

   C. Straightedge

   D. Bulldog snips

   E. Right- and left-cutting snips

   F. Square

   G. Sheet metal hammer

   H. Sheet metal as selected by instructor

   I. Floor and hand tools as required for finishing

II. Procedure (See Figures 32 and 33)

   A. Block out 19 ¼" × 10" area on sheet metal

   B. Transcribe all measurements from Figure 33 to sheet metal with awl and straightedge

   C. Cut out pattern with bulldogs, left- and right-cutting snips, as shown in Figure 33

   D. Select hand or floor tools appropriate to specifications and form and finish the duct

   (NOTE: When in doubt about tool selection or forming procedure, ask your instructor for assistance.)

   E. Have your instructor check your work

   F. Return tools and materials to proper storage areas

JOB SHEET #5

FIGURE 32: Isometric view

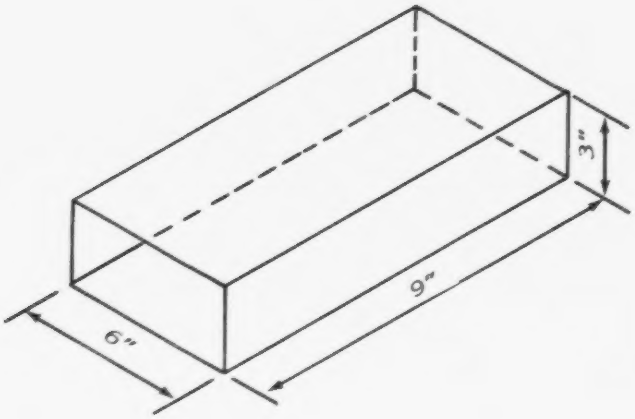
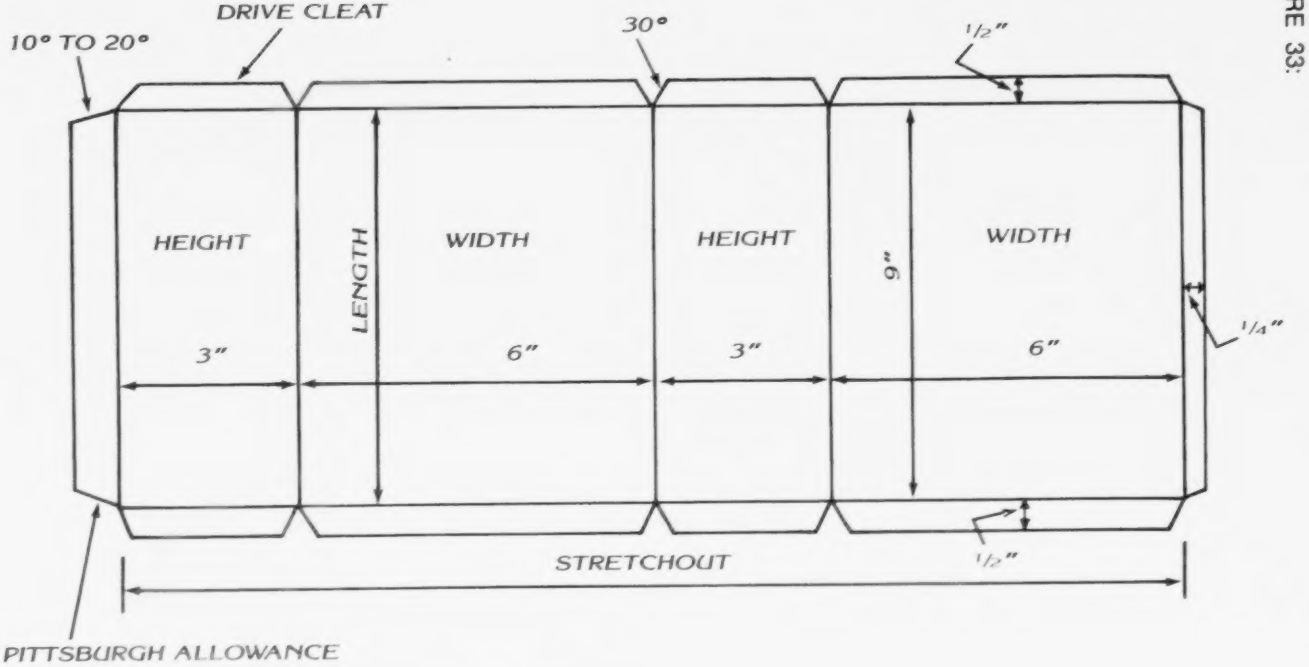


FIGURE 33:


DRIVE CLEAT
10° TO 20°
30°
1/2"
HEIGHT
LENGTH
WIDTH
HEIGHT
9"
WIDTH
1/4"
3"
6"
3"
6"
1/2"
STRETCHOUT
PITTSBURGH ALLOWANCE

JOB SHEET #5

INTRODUCTION TO SHEET METAL
UNIT IV

JOB SHEET #6 — LAY OUT AND CUT SHEET METAL FOR A CYLINDER, THEN JOIN CYLINDER TO A FLAT SURFACE WITH A DOVETAIL NOTCH

I. Tools and materials

   A. Circumference rule

   B. Scratch awl

   C. Scratch gauge

   D. Right- and left-cutting snips

   E. Sheet metal hammer

   F. Straight snips

   G. Sliproll

   H. Cold chisel

   I. Hand notcher

   J. Face shield

   K. Spot welder

   L. 26-gauge galvanized sheet metal as selected by instructor

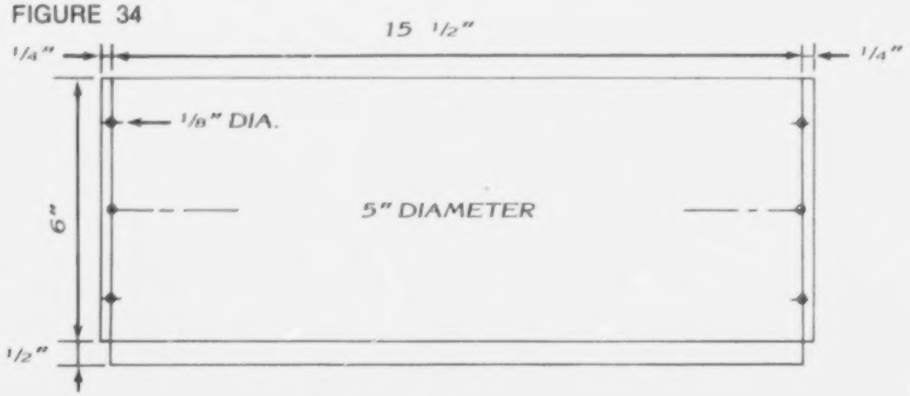
II. Procedure

   A. Measure and scribe on a piece of sheet metal a plate 6 inches wide and 15 1/2 inches long

   (NOTE: 15 1/2 inches is the circumference number shown on the circumference rule which determines the length of the plate for a 5-inch diameter.)

   B. Add 1/2-inch to the width, 1/2-inch to the length, then scribe the plate accordingly (Figure 34)

FIGURE 34



JOB SHEET #6

(NOTE: 1/8-inch diameter will be used only if rivets are used on the seam.)

C. Cut out the plate according to the layout

D. Use a sliproll to roll the plate into a cylinder

1. Position yourself on the working side of the sliproll so that the handle is to your right

   (NOTE: If you are left handed, use your right hand; almost all hand-operated equipment in sheet metal shops is designed for right-handed operation; develop the right-hand habit from the start and it won't be a problem later.)

2. Position the plate with the lap mark turned down away from the roll

3. Insert the opposite end of the plate between the two front rolls of the sliproll with your left hand

   CAUTION

   Keep your fingers at a safe distance from the rollers when working with a sliproll.

4. Turn sliproll handle away from you in a clockwise motion. Plate passes completely through the rollers and is formed into a cylinder

E. Inspect your work, then have your instructor check your work

F. Use spot welder to fasten seams

CAUTION

Do not use spot welder until you have been thoroughly instructed in the use of it and have your instructor's permission to use it.

1. Have instructor set the amperage and timing on the welder

   (NOTE: Amperage and timing on a spot welder are set according to the thickness of the metal being used, so make it a habit to check amperage and timing before starting each job.)

2. Put your face shield on

3. Place the overlapping edge of cylinder evenly along the lap line on the opposite edge of the cylinder

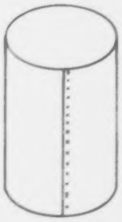
4. While holding both edges firmly, insert the cylinder over the bottom arm of the welder as you double-check alignment of the seam

5. Step on the spot welder pedal to bring the top arm down to contact the metal

JOB SHEET #6

6. Repeat this procedure along the outside seam every ½ to ¾ inch
7. Turn the cylinder just far enough that the points on the spot welder will contact the inside seam
8. Step on the welder pedal to bring the top arm down to contact the metal
9. Repeat this procedure until the seam is made (Figure 35)

FIGURE 35

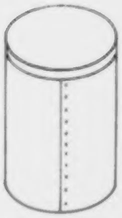


10. Allow the cylinder to cool or cool it in a water tank
11. Inspect your work and have your instructor check your work

G. Prepare cylinder for dovetail notch

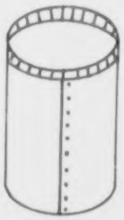
1. Set the scratch gauge at ½ inch
2. Make a mark completely around one end of the cylinder (Figure 36)

FIGURE 36



3. Use right- or left-cutting snips and cut to the ½-inch mark in increments of ½-inch all around the cylinder, or use a hand notcher (Figure 37)

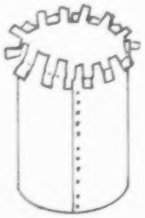
FIGURE 37



JOB SHEET #6

4. Bend every other tab 90 degrees outward (Figure 38)

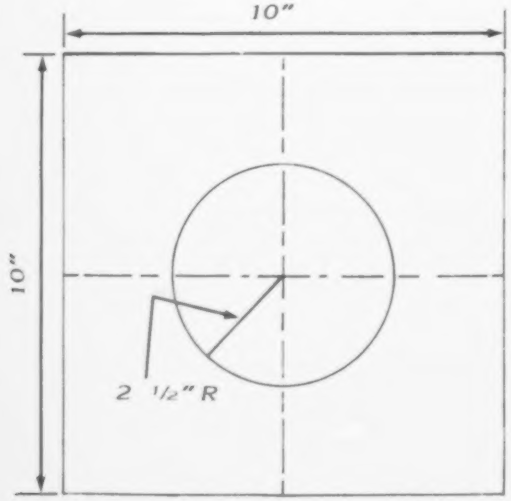
FIGURE 38



H. Prepare square sheet and cylinder for assembly

1. Measure and scribe on a piece of sheet metal a plate 10 inches square
2. Cut out 10-inch square plate
3. Locate center of the square plate
4. Scribe a 5-inch circle in the center of the 10-inch plate (Figure 39)

FIGURE 39

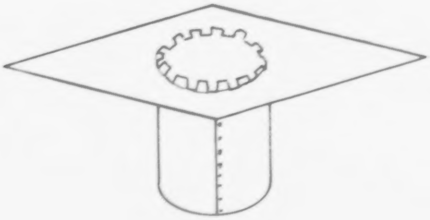


JOB SHEET #6

(NOTE: Circle can be made by using dividers or by centering the smooth end of notched pipe on the plate, then scribing around the outside of pipe.)

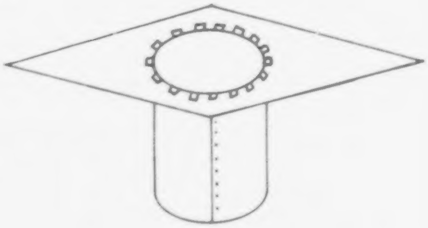
5. Use hammer and chisel to cut a hole in the plate near the center of the circle
6. Use right- or left-cutting snips to cut out the circle on the scribed line; waste the circle
7. Insert straight tabs of notched pipe through the hole in the plate (Figure 40)

FIGURE 40



8. Use sheet metal hammer to flatten the tabs against the plate (Figure 41)

FIGURE 41



9. Inspect the dovetail seam and have your instructor check your work
10. Clean up area and put away tools and materials

SHEET METAL BASIC SKILLS
UNIT IV

TEST

NAME ______________________________ SCORE ______________

1. Match terms associated with sheet metal basic skills to their correct definitions. Write the correct numbers in the blanks.

______a. Procedure or method by which two pieces of metal are joined together

______b. Similar to seam; usually refers to applications where ends of ducts are joined or where bottoms of pans or boxes are formed

______c. Piece or pieces of metal formed specifically for holding two or more sections of duct together

______d. Procedure or method of stiffening or adding strength to the edge of a piece of metal by reforming the metal or adding preformed metal to eliminate raw edges

______e. Angle cut in the edge of a piece of metal to facilitate the forming of seams, hems, and joint allowances

______f. Any point where two pieces of round or rectangular duct join together or where fittings join duct

______g. Material intended to be bent for an anchoring point or a lap allowance

______h. Lock formed by placing one piece of duct inside another and securing it with dovetailed tabs

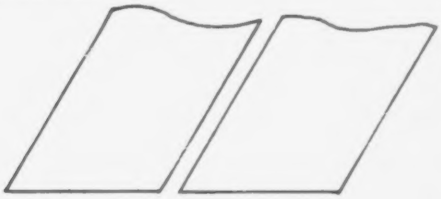
1. Edge
2. Notch
3. Seam
4. Lock
5. Clip
6. Tab
7. Joint
8. Tap in

TEST

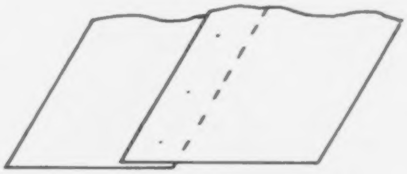
2. Identify the basic types of seams in the following illustrations. Write the correct names in the blanks.

Lap seam
Standing seam
Butt seam
Grooved lock seam

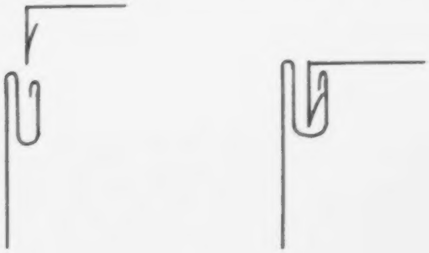
Acme or hammerlock pipe seam
Pittsburgh seam
Snap-lock Pittsburgh seam



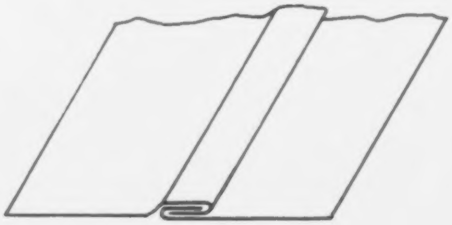
a. ________________________



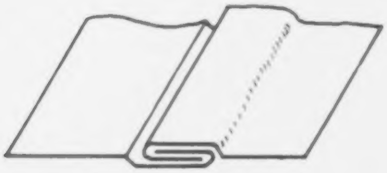
b. ________________________



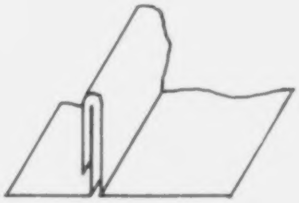
c. ________________________



d. ________________________



e. ________________________



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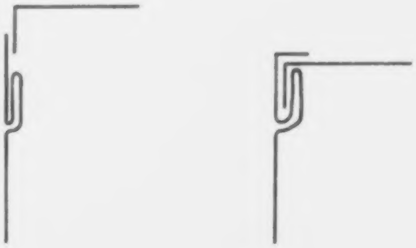


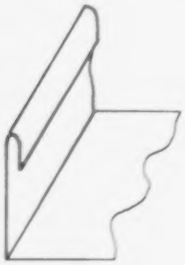
g. ________________________

TEST

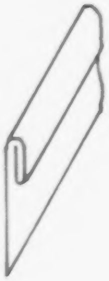
3. Identify the basic types of hems in the following illustrations. Write the correct names in the blanks.

Outside hem
Double hem

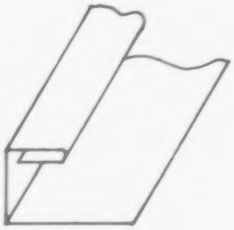
Standing hem
Inside hem



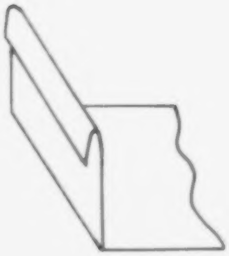
a. ____________________



b. ____________________



c. ____________________

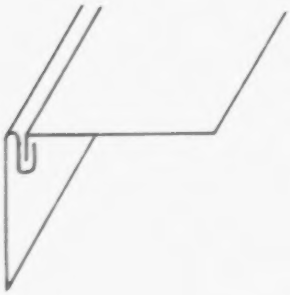


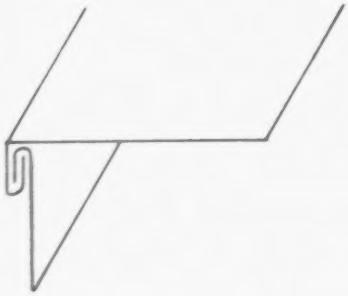
d. ________________________________

TEST

4. Identify the basic types of locks illustrated. Write the correct names in the blanks.

Sliplock
Coffin lock

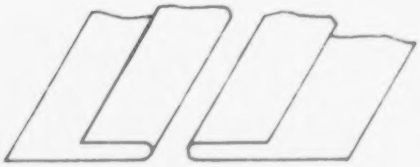


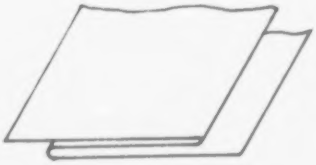


a. ______________________ b. ______________________

5. Identify the basic types of clips illustrated. Write the correct names in the blanks.

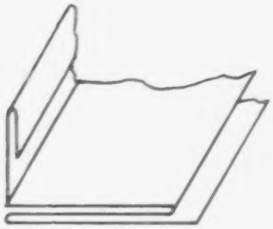
Standing hem S-clip
S-clip
Edges for connecting drive clips
Drive clip



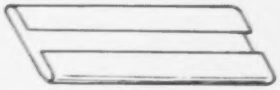


a. ______________________ b. ______________________

TEST



c. ______________________________



d. ______________________________

6. Match basic types of notches to their descriptions. Write the correct numbers in the blanks.

_____a. Used for connecting round pipe to a rectangular duct or a flat sheet

_____b. A 30-degree notch ½ inch deep angling into a straight notch which joins the seam allowance line only on transitional duct

_____c. A notch angled at approximately 30 degrees; used on all corners and sides in duct work

_____d. Used on corners of boxes and pans when the sides bend 90 degrees from the bottom

_____e. A 30-degree V-shaped notch made on the Pittsburgh side where the metal will be bent across a seam

_____f. A notch angled at exactly 45 degrees to give a picture frame appearance

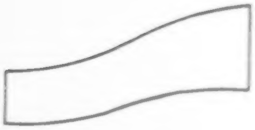
_____g. A notch angled 20 to 30 degrees; designed to overlap corners; usually secured by spot welding or riveting

1. Duct notch
2. Center Pittsburgh notch
3. Lap notch
4. Dovetail notch
5. Corner notch
6. 45-degree lap notch
7. Corner Pittsburgh notch for transitional duct

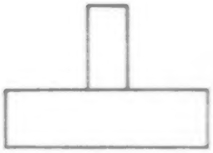
TEST

7. Identify basic types of sheet metal fittings. Write the correct names in the blanks.

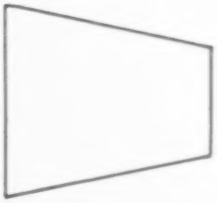
Tee
Offset
Boot
Angle
Square to round transition
Change offset
Curved-throat elbow
Square-throat elbow
Transition
Y-branch
Angle tee
Change elbow



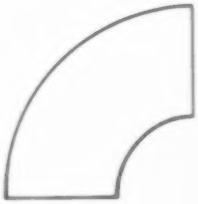
a. ______________________________



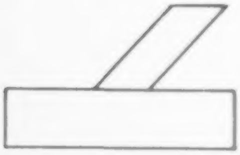
b. ______________________________



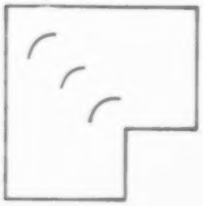
c. ______________________________



d. ______________________________

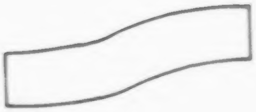


e. ______________________________

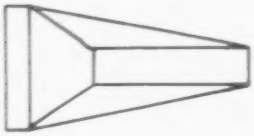


f. ______________________________

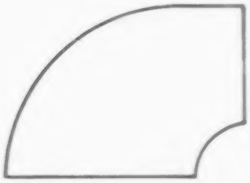
TEST



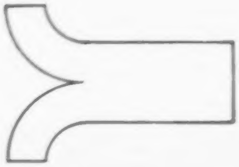
g. ____________________



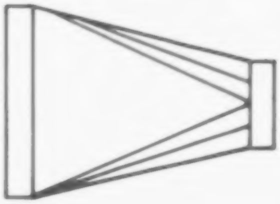
h. ____________________



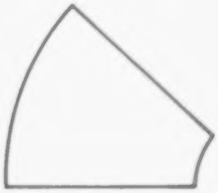
i. ____________________



j. ____________________



k. ____________________



l. ____________________

(NOTE: Test item 8 lists the job sheets. They are an important part of this test. If they have not been completed, check with your instructor.)

8. Demonstrate the ability to

   a. Lay out, then cut with straight snips a 4" × 3" metal rectangle.

   b. Lay out, then cut with left-cutting snips a 3-inch metal circle.

   c. Lay out, then cut with right-cutting snips a 3-inch metal circle.

TEST

d. Lay out and form to specifications a metal box.

e. Lay out and form to specifications a rectangular duct.

f. Lay out and cut sheet metal for a cylinder, then join cylinder to a flat surface with a dovetail notch.

SHEET METAL BASIC SKILLS
UNIT IV

ANSWERS TO TEST

1.
   a. 3
   b. 4
   c. 5
   d. 1
   e. 2
   f. 7
   g. 6
   h. 8

2.
   a. Butt seam
   b. Lap seam
   c. Snap-lock Pittsburgh seam
   d. Grooved lock seam
   e. Acme or hammerlock pipe seam
   f. Standing seam
   g. Pittsburgh seam

3.
   a. Inside hem
   b. Double hem
   c. Standing hem
   d. Outside hem

4.
   a. Coffin lock
   b. Sliplock

5.
   a. Edges for connecting drive clips
   b. S-clip
   c. Standing hem S-clip
   d. Drive clip

6.
   a. 4
   b. 7
   c. 1
   d. 5
   e. 2
   f. 6
   g. 3

7.
   a. Change offset
   b. Tee
   c. Transition
   d. Curved-throat elbow
   e. Angle tee
   f. Square-throat elbow
   g. Offset
   h. Boot
   i. Change elbow
   j. Y-branch
   k. Square to round transition
   l. Angle

8. Performance skills evaluated to the satisfaction of the instructor.

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